

Late Campanian-Maastrichtian corals from the United Arab Emirates-Oman border region

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SYNOPSIS. 43 species of 34 genera of scleractinian corals and 1 genus of octocoral from the Qahlah and Simsima Formations of the United Arab Emirates-Oman border region are described. The faunas are dominated by colonial forms including the taxa *Actinastrea*, *Columactinastraea*, *Stylophora*, *Monticulastraea*, *Neocoenia*, *Stephanaxophyllia*, *Columastrea*, *Paraplacocoenia*, *Astrogyra*, *Placosmia*, *Diplocoenia*, *Calamophylliopsis*, *Agathelia*, *Diploctenium*, *Cladophyllia*, *Glenarea*, *Dendrophyllia*, *Barysmilia*, *Orbignygyra*, *Astraraea*, *Pseudofavia*, *Goniopora*, *Actinacis*, *Brachycoenia*, *Mesomorpha*, *Fungiastrea*, *Brachyphyllia*, *Aspidastraea*. The occurrence of solitary corals is strongly dominated by *Cunulolites*, with a minor appearance of *Montlivaltia*, *Aulosmilia*, *Phragmosmilia*, *Diegosmilia* and *Trochocyathus*.

INTRODUCTION

During the period 1991–1995 members of the Palaeontology Department of The Natural History Museum collected and described Upper Cretaceous macrofossils during their investigations of the Qahlah and Simsima Formations in the Oman Mountains of the United Arab Emirates-Oman border area. Previous results have been published on the lithofacies of the Qahlah and Simsima Formations (Smith *et al.*, 1995a), echinoids (Smith, 1995), ammonites (Kennedy, 1995), nautiloids and inoceramids (Morris, 1995), bryozoans (Taylor, 1995), brachiopods (Owen, 1995), and rudists (Morris & Skelton, 1995). In addition, studies on the palaeoenvironment dealing with echinoid-mollusc-coral assemblages provided the first information about the coral associations (Smith *et al.*, 1995b).

This paper adds to our knowledge of these Upper Cretaceous

faunas by providing a detailed description of the corals of the Qahlah and Simsima Formations.

STUDY AREA

The study area lies along the border between the United Arab Emirates and the Sultanate of Oman (Fig. 1). The corals were collected from outcrops, comprising outlying jebels (hills) along the western fringes of the Oman Mountains (Figs 2–4): **Jebel Huwayyah**, 10 km NE of Al Ain; **Jebel Bu Milh**, ca. 40 km NE of Al Ain; **Jebel Rawdah**, east of Al Madam; **Jebel Buhays**, 4 km north of Al Madam; **Jebel Thanais**, 4 km north of Al Madam; **Jebel Faiyah**, north of Al Madam, and **Qarn Murrah**, 15 km north of Al Madam. Detailed information on the sections logged and studied are given in Smith *et al.* (1995a).

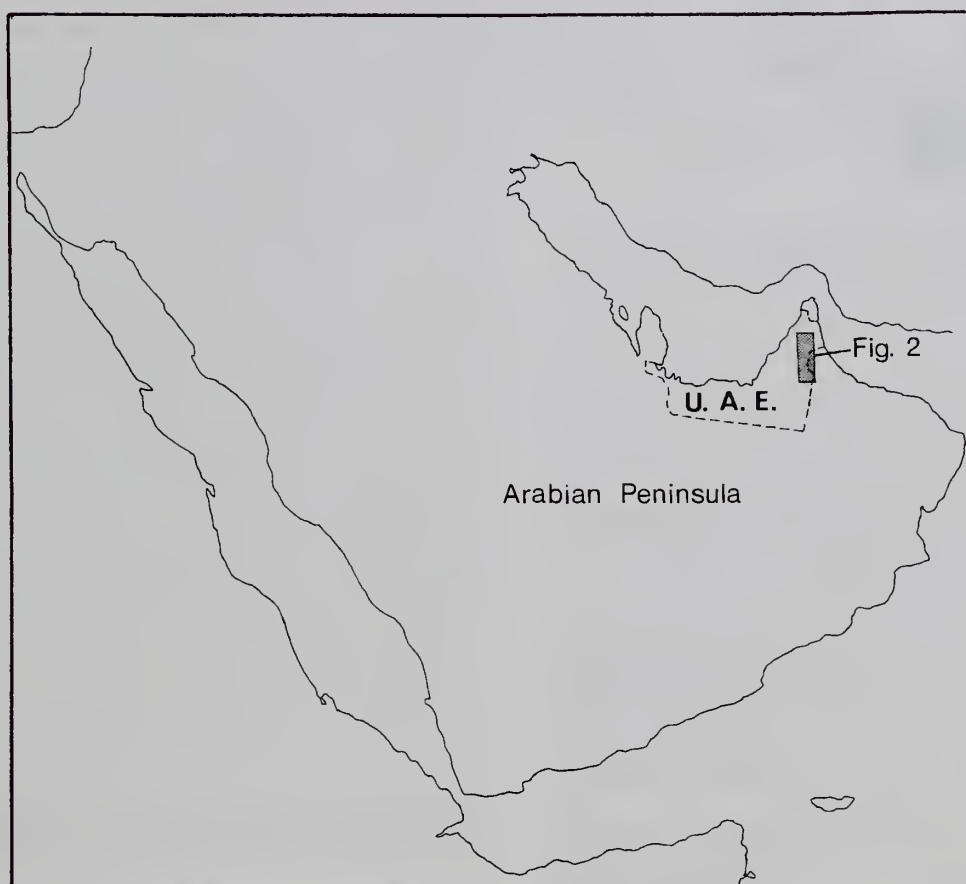


Fig. 1 Map of the Arabian Peninsula showing the area of study.



Fig. 2 Locality map showing the position of the four major jebels (hills) studied (asterisked) where there are important outcrops of late Cretaceous sediments.

STRATIGRAPHY

The Upper Cretaceous to Lower Palaeocene rocks of the Oman Mountains area of the United Arab Emirates-Oman border area are divided into three units (Skelton *et al.*, 1990):

3. The **Pabdeh Group** – a basal limestone conglomerate of re-worked Simsima Formation with an erosive base of presumably early Palaeocene age, overlain by thin-bedded basal marls of late Palaeocene age.
2. The **Simsima Formation** – a platform carbonate sequence of Maastrichtian age.
1. The **Qahlah Formation** – a marine clastic sequence of sands and conglomerates of late Campanian or early Maastrichtian in age.

Combining the evidence from ammonites, inoceramid bivalves,

echinoids and global sea-level curves Smith *et al.* (1995a) concluded that the basal beds of the Qahlah Formation are of latest Campanian age. At Jebel Huwayyah, the *Loftusia*-rich levels of the Qahlah Formation probably encompass Lower to early Upper Maastrichtian. The Simsima Formation appears to be early Upper Maastrichtian, *fresvillensis* Zone or later.

SYSTEMATIC DESCRIPTIONS

Abbreviations for the dimensions in the text are as follows: **d** = corallite diameter; **d (*)** = corallite diameter recorded in less than 10% of the calices in the same individual; **d (max)** = maximum calicular diameter; **d (min)** = minimum calicular diameter; **dl** = diameter of lumen; **c-c** = distance between centres of calices; **c-c (series)** = distance between centres of the same calicinal series; **c-c (series): (n)** = distance between centres of the same calicinal series occurring in less than 10% of the measurements in the same individual; **s** = number of septa; **s (*)** = number of septa occurring in less than 10% of the corallites of the same individual; **s/mm** = density of septa measured on ridges or outer calicinal regions, if not indicated otherwise; **h** = height of corallum, note that the terms **cycles** and **orders** of septa are used in the sense that septa of the same cycle belong to a single stage in ontogeny, septal orders refer to the different sizes of septa; the notation **S1, S2**, etc. refers to either cycles or orders; **(st)** = height of corallum from stem to upper surface; **(e)** = height of corallum from the extremities to upper surface.

Note that microstructural features are not preserved, if not indicated otherwise in the descriptions. The terms **minitrabeculae**, **medium-sized trabeculae** and **thick trabeculae** are used in the sense proposed by Morycowa & Roniewicz (1995a), according to which minitrabeculae are up to 50 µm in size, medium-sized trabeculae measure 50 to 100 µm, and thick trabeculae are over 100 µm in size. **Centres of calcification** are used in that due to the poor preservation the size of the trabeculae cannot be identified. In cases where the axial structures 'pali' and 'paliform lobes' cannot be distinguished they have simply been referred to in the taxonomic description as 'paliform structures'.

The coral classification for the genera used herein is a combination of several different models: taxonomic levels organized by Vaughan & Wells (1943) concern the suborders Faviina, Dendrophylliina, Caryophylliina, Fungiina, and the families Faviidae, Montlivaltiidae, Dendrophylliidae, Haplaraeidae, Poritidae, Actinacidae and Caryophylliidae. Later modifications by Alloiteau (1952a) concern the suborders Archaeocoeniina, Stylinina, Meandriina, and the families Actinastreaeidae, Stylophoridae, Heliastreaeidae, Columastreaeidae, Placocoeniidae, Placosmiliidae, Isastreaeidae, Dendrogyridae, Meandriidae, Andemantastraeidae and Parasmiliidae. Further changes in the coral classification are due to the works by L. & M. Beauvais (1975) for the family Agatheliidae; Roniewicz (1976) for the suborder Rhipidogyrina, and the families Rhipidogyridae and Dermosmiliidae; Morycowa & Roniewicz (1990) for the family Cladophylliidae; Morycowa & Roniewicz (1995b) for the suborder Microsolena, and the families Latomeandriidae and Cunnolitiidae; and Baron-Szabo (herein) for the family Brachyphylloidae.

The material is deposited at the Department of Palaeontology, The Natural History Museum, London, and registration numbers have the prefix AZ.

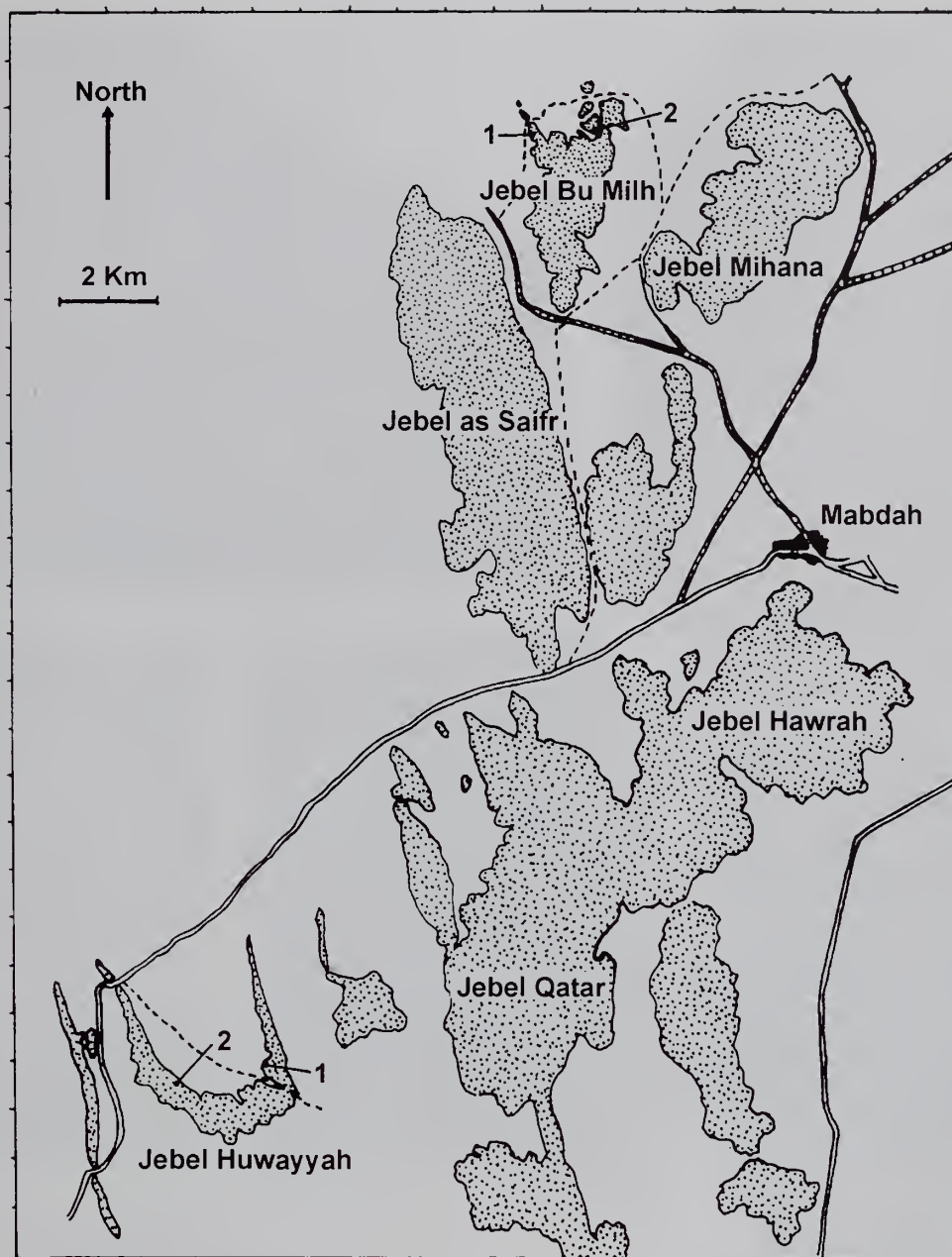


Fig. 3 Detailed locality map for Jebel Huwayyah and Jebel Bu Milh.

Class ANTHOZOA Ehrenberg, 1834
 Subclass ZOANTHARIA Blainville, 1830
 Order SCLERACTINIA Bourne, 1900
 Suborder ARCHAEOCOENIINA Alloiteau, 1952
 Family ACTINASTREIDAE Alloiteau, 1952
 Genus ACTINASTREA d'Orbigny, 1849

TYPE SPECIES. *Astrea geminata* Goldfuss, 1826.

Actinastrea bastidensis Alloiteau, 1954 Pl. 1, fig. 2

*1954 *Actinastrea bastidensis* Alloiteau: 84–87, pl. III, fig. 4, pl. X, fig. 4.

v1998 *Actinastrea bastidensis* Alloiteau; Baron-Szabo: 129, pl. 1, fig. 5.

MATERIAL. AZ 48; AZ 639 (two specimens).

MEASUREMENTS. d: (*1.2) 1.5–2.2 mm; c–c: 1.5–2.2 mm; s: 24 (*+s4); size of the colony: domal shaped: 7 cm in height, with a varying diameter of about 4 to 5 cm; knobby: 2.5–4 cm in diameter.

DESCRIPTION. Massive-domal, or knobby, cerioid corallum with calices that are directly united by their walls. Corallites are poly-

gonal in outline. Gemmation is due to extracalicular and to a lesser extent intracalicular budding. Costosepta are compact, nonconfluent or subconfluent, and arranged in 3 cycles in 6 systems, radially and bilaterally. Septa of the first cycle extend to, and may fuse with, the columella. Septa of the second cycle are nearly of the same length, but distinctly thinner. Septa of the third cycle regularly alternate with the second cycle septa. In some calices the beginning of a fourth cycle is present. Lateral surfaces of the septa are covered with spiniform and rounded granules. The columella is styliform. The wall is septothecal with lacunae. Endothecal dissepiments are thin and vesicular. Microstructure is poorly preserved, but in places minor or medium-sized centres of calcification are present.

OCCURRENCE. Simsima Formation, lowest 2 m, Jebel Faiyah, 5 km north of Al Madam; outcrop on the east face, ca. 3 km north of the southern tip of Jebel Faiyah, NNE of Al Madam.

DISTRIBUTION. Upper Santonian of southern France (Corbières), Campanian of northern Spain (Catalonia).

Actinastrea ramosa (Michelin, 1847) Pl. 1, fig. 3

*1847 *Astrea ramosa* Michelin: 303, pl. 72, fig. 4.

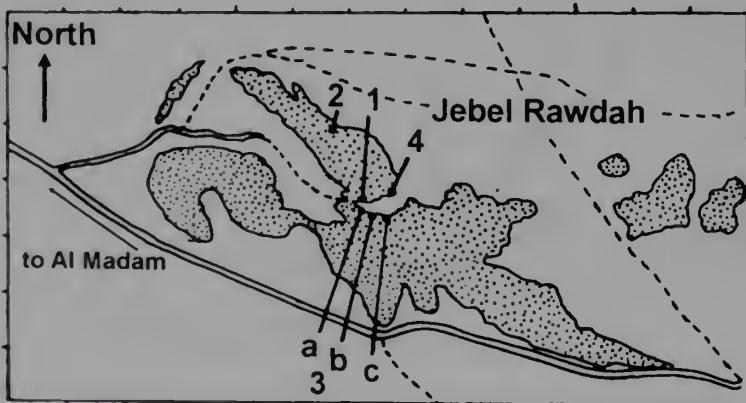
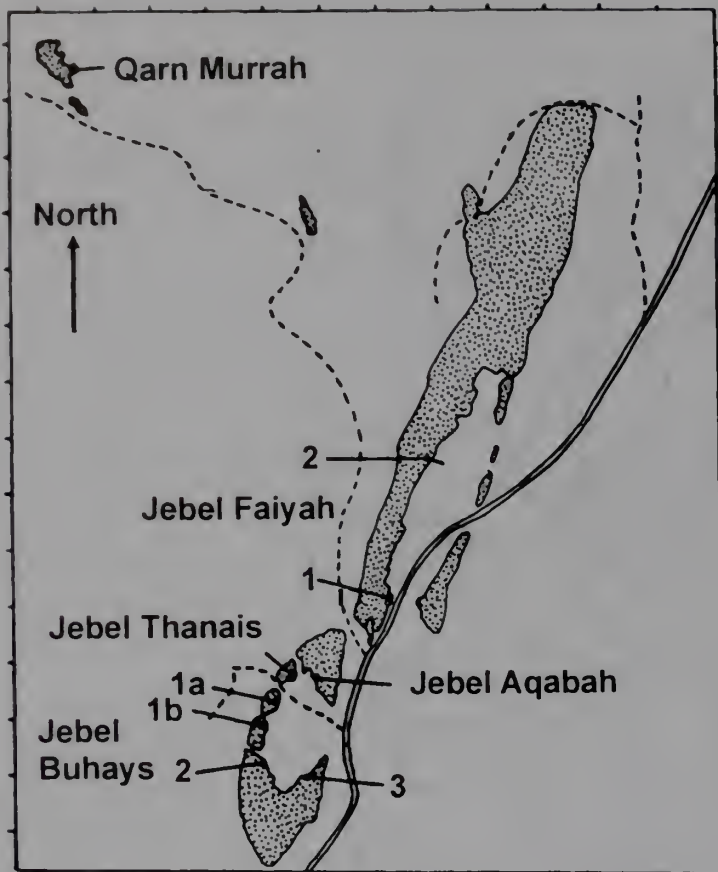


Fig. 4 Detailed locality map for Qarn Murrah and Jebels Buhays, Thanais, Aqabah and Faiyah (upper), and Jebel Rawdah (lower).

- 1848 *Astrocoenia ramosa* (Michelin); Milne Edwards & Haime: 298.
 1861 *Astrocoenia ramosa* (Michelin); Fromentel: 233.
 1954 *Actinastrea ramosa* (Michelin); Alloiteau: 53, pl. IV, fig. 3, pl. VIII, fig. 3.
 ?1956 *Astrocoenia ramosa* (Michelin); Bendukidze: 114.

- 1978 *Actinastrea ramosa* (Michelin); Turnšek, in Turnšek & Polšak: 145, 166, pl. 1, figs 1–3.
 1982 *Actinastrea ramosa* (Michelin); Beauvais, tome I: 16 (older synonyms cited therein).
 1989 *Actinastrea ramosa* (Michelin); Löser: 96, text-fig. 1.
 1994 *Actinastrea ramosa* (Michelin); Turnšek: 9, pl. 1, figs 5–6.
 1997 *Actinastrea ramosa* (Michelin); Löser: 79, pl. 1, fig. 1.

MATERIAL. AZ 365; AZ 662; AZ 896.

MEASUREMENTS. d: (*0.8) 1–1.3 mm; c–c: 0.9–1.5 mm; s (adult): 16 (8s₁+8s₂), s (juvenile): 10 (5s₁+5s₂) – 12 (6s₁+6s₂); size of the colony: 6–11 cm in diameter.

DESCRIPTION. The corallum forms a massive and cerioid colony with corallites united by their walls. Calices are polygonal in outline. Gemmation is due to intra- and extracalicular budding. Costosepta are compact, non- or sub-confluent, finely granulated on their lateral surfaces, 16 in number, which are arranged in 2 orders in 8 systems. Septal development in five or six systems is present in juvenile corallites. Septa of the first order extend to, and may fuse with, the columella. Septa of the second order are distinctly thinner, reaching about half the length of the oldest ones. The columella is styliiform. Wall is septothecal with lacunae. The endotheca consists of very thin vesicular or subtabulate dissepiments.

REMARKS. The occurrence of septal arrangements in the juvenile stage differing from the ones in the adult stage indicates an inconsistency in the ontogenetical development of the septal apparatus. Therefore, the septal arrangement corresponds to size orders rather than to cycles.

OCCURRENCE. *Loftusia* Bed (beds 3–8), SW corner of Jebel Huwayyah, east of Al Ain; east face of northern hill forming Jebel Buhays, 4 km north of Al Madam; from bed 19 north side of valley, 2 km east of Jebel Rawdah, east of Al Madam.

DISTRIBUTION. Upper Cenomanian of Germany (Saxony), ?Senonian of Georgia (in Caucasia) and Hungary, Coniacian-Campanian of Austria (Gosau Group), Santonian-Campanian of Slovenia, Upper Santonian of southern France (Corbières) and northern Spain (Catalonia), Campanian of Turkey.

Actinastrea elongata Alloiteau, 1954 Pl. 1, fig. 6

*1954 *Actinastrea elongata* Alloiteau: 41, pl. I, fig. 10, pl. VII, fig. 4.

MATERIAL. AZ 208; AZ 571; AZ 905; 3.4X.

MEASUREMENTS. d (max): (*1.8) 2.2–3 mm; d (min): 1.5–2.2; c–c: 1.5–3 mm; s: 20 (10s₁+10s₂); size of the colony: about 15 cm in diameter.

DESCRIPTION. Massive colony with corallites that are polygonal or slightly rounded in outline. Gemmation is due to extracalicular and intracalicular budding. Costosepta are compact, straight, developed

PLATE 1

Micrographs of plocoid (1, 7) and cerioid (2–6) coral colonies from transverse thin-sections and upper surface views.

Figs 1, 7 *Stylophora octophylla* (Felix, 1906); 1, AZ 560; 7, AZ 548.

Fig. 2 *Actinastrea bastidensis* Alloiteau, 1954; AZ 639.

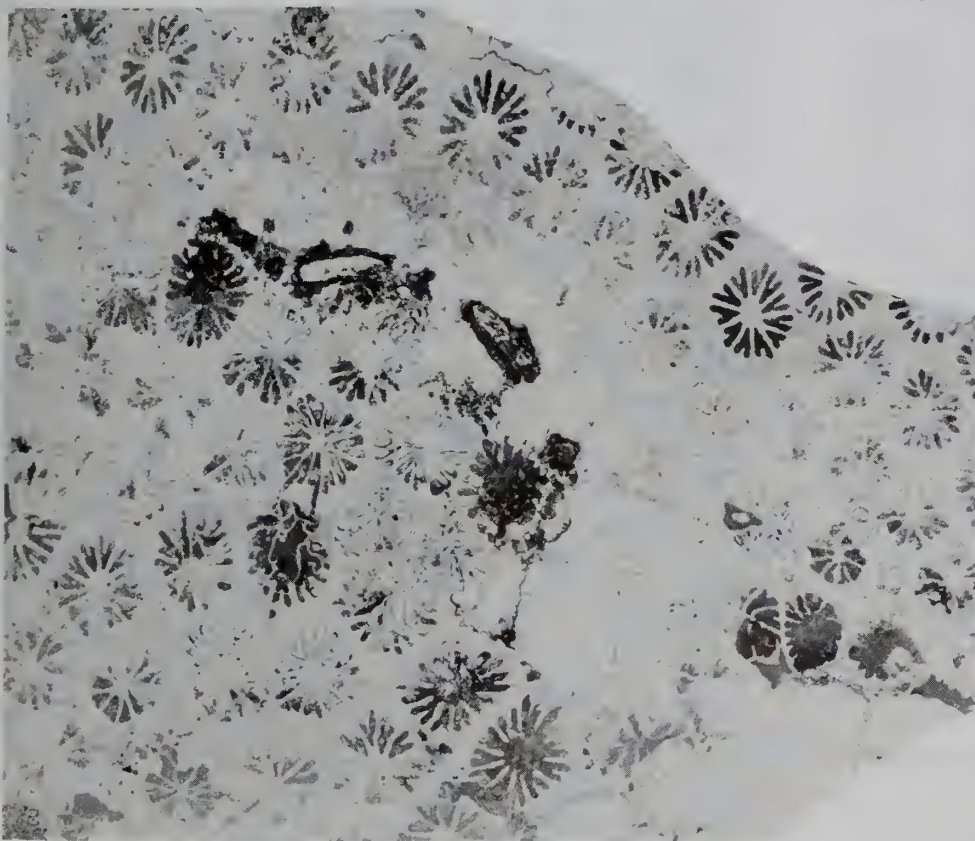
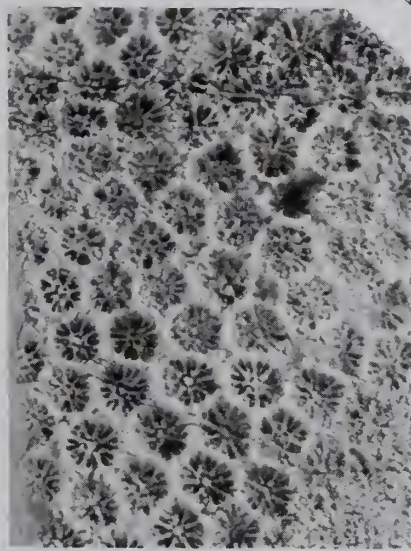
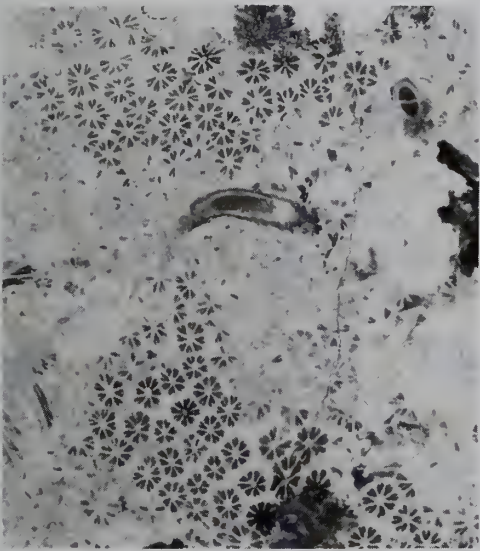
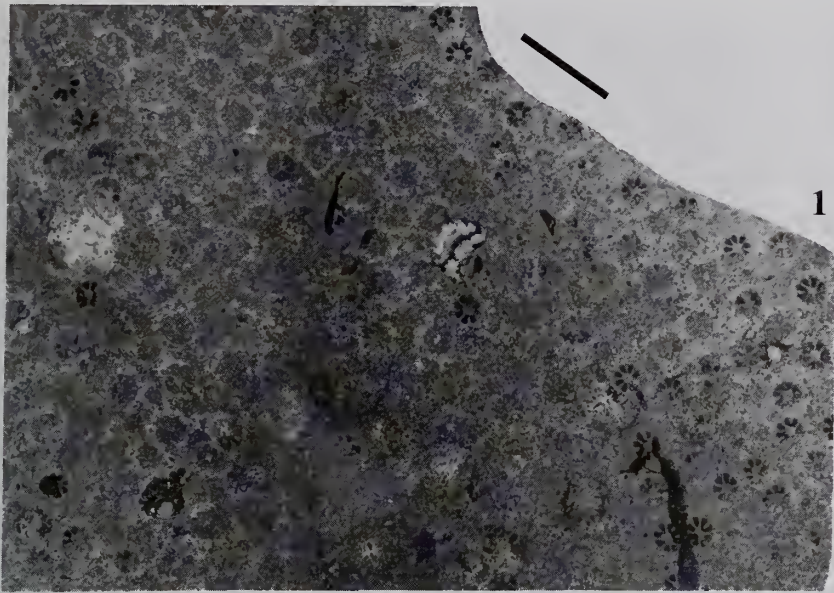
Fig. 3 *Actinastrea ramosa* (Michelin, 1847); AZ 365.

Fig. 4 *Columactinastraea pygmaea* (Felix, 1903); AZ 471.

Fig. 5 *Columactinastraea guadelupae* (Wells, 1932); AZ 2539.

Fig. 6 *Actinastrea elongata* Alloiteau, 1954; AZ 905.

Scale bar = 3 mm.



in 2 complete cycles in 10 systems, and have delicate spiniform granules laterally. In general, septa of the first cycle extend to the centre of the calice where their inner ends may merge with the columella. Septa of the second cycle are distinctly shorter, reaching about one-quarter the length of the oldest ones. The columella is styliform or substyliform, well-developed. Wall is septothecal with rare pores. Endotheca consists of a small number of thin, subtabulate dissepiments. Septal microstructure is made of simple medium sized trabeculae, sometimes producing ?lateral trabeculae.

OCCURRENCE. Qahlah Formation, *Lofusius* beds, SW corner of Jebel Huwayyah, east of Al Ain.

DISTRIBUTION. Maastrichtian of France.

Genus *COLUMACTINASTRAEA* Alloiteau, 1952

TYPE SPECIES. *Columactinastraea rennensis* Alloiteau, 1952.

Columactinastraea pygmaea (Felix, 1903)

Pl. 1, fig. 4, Pl. 2, fig. 4

- *1903b *Astrocoenia pygmaea* Felix: 54, pl. 3, figs 4–5.
 1914 *Astrocoenia pygmaea* Felix; Felix, pars 7: 235.
 1954 *Actinastrea pygmaea* (Felix); Alloiteau: 52, pl. IV, fig. 6, VIII, fig. 2.
 1975 *Actinastrea pygmaea* (Felix); Beauvais *et al.*: 44, pl. IV, figs 1a, b.
 1978 *Columactinastraea pygmaea* (Felix); Turnšek, *in* Turnšek & Polšak: 147, 168, pl. 3, figs 1–4.
 1994 *Columactinastraea pygmaea* (Felix); Turnšek: 9, pl. 2, figs 1–3.
 1997 *Columactinastraea pygmaea* (Felix); Turnšek: 39, figs 39A–C.
 v1998 *Columactinastraea pygmaea* (Felix); Baron-Szabo: 130, pl. 2, fig. 1.

MATERIAL. AZ 213; AZ 471; AZ 537; AZ 541; AZ 553; AZ 555; AZ 558; AZ 928.

MEASUREMENTS. d: (*0.9) 1.1–1.7 mm; c–c: (*1) 1.3–2.2 mm; s: 8s1+8s2 (*+s3); size of the colony: 2.5–10 cm in diameter.

DESCRIPTION. The corallum is massive-knobby and cerioid with calices which are polygonal or slightly rounded in outline. Costosepta are arranged in two complete cycles in 8 systems. In some calices the beginning of a third cycle is visible. Septa of the first two cycles can be subequal or regularly alternating in length and thickness. Youngest septa are distinctly thinner and shorter. Septa are compact and non- or subconfluent. Their lateral surfaces have numerous delicate granulations. Paliform structures irregularly occur in front of first and second cycle septa. The columella is styliform or consists of a few papillae, sometimes fusing with one of the oldest septa. The wall is septothecal with rare pores. The endotheca is made of vesicular dissepiments.

OCCURRENCE. Main Gastropod Level (beds 7/8), north side of Jebel Bu Milh, 25 km NE of Hili; *Lofusius* Beds, Qahlah Formation,

SE corner of Jebel Huwayyah, east of Al Ain; outcrop at southern tip of Jebel Faiyah (lowest 3 m of section), 6 km NNE of Al Madam.

DISTRIBUTION. Santonian-Campanian of southern France, Slovenia, and Croatia, Campanian of Portugal.

Columactinastraea guadelupae (Wells, 1932) Pl. 1, fig. 5

- v*1932 *Stephanocoenia* (?) *guadelupae* Wells: 235, pl. 32, figs 8, 9, pl. 39, fig. 3.
 1944 *Stephanocoenia guadelupae* Wells; Wells: 433, pl. 69, figs 3,4.
 v1998 *Columactinastraea guadelupae* (Wells); Baron-Szabo: 130, pl. 2, fig. 1.

MATERIAL. AZ 483; AZ 504; AZ 900; AZ 907–13; AZ 915; AZ 919–22; AZ 933–34; AZ 2536; AZ 2539.

MEASUREMENTS. Comparison of the dimensions (in mm) of skeletal elements of the specimens from UAE/ Oman (here), Spain (Baron-Szabo, 1998) and Texas (Wells, 1932).

	UAE/Oman	Spain	Texas
d:	2–4	(2,5) 3–4,5	2,5–4
dl:	(*1.5) 2–2.5	1,8–2,5	1,7) 2,2
c–c:	2–4	3–4,5	(not stated)
s:	(22) 24	(20) 24	24

*size of the colony = 3–11 cm in diameter.

DESCRIPTION. The corallum is a massive, nodular or lamellar colony with calices which are rounded or subpolygonal in outline. Costosepta are arranged in three complete cycles in 6 systems, irregularly alternating in length. They are compact, non- or subconfluent and have spiniform granules laterally. Septa of the first and second cycle can be of the same thickness. Their inner ends have separate pali that appear to form a ring of 8–12 around the columella. The columella is styliform or substyliform. Third cycle septa are very short, appearing as small thorns. The wall is a well-developed septotheca with rare pores. The endotheca consists of vesicular or subtabulate dissepiments.

REMARKS. The specimens from the UAE/ Oman closely correspond to both the type and the material from Spain.

OCCURRENCE. Qahlah Formation (beds 10/ 11, above level of 1st ammonite *Lofusius* beds, and coral clast horizon), SE corner of Jebel Huwayyah, east of Al Ain; NW end of Jebel Milh, 25 km NE of Hili.

DISTRIBUTION. Upper Aptian-Lower Albian of Venezuela (Barranquin Formation), Middle Albian of Texas, Campanian of northern Spain (Catalonia).

Family **STYLOPHORIDAE** Milne Edwards, 1857

Genus *STYLOPHORA* Schweigger, 1819

TYPE SPECIES. *Madrepora pistillata* Esper, 1792.

PLATE 2

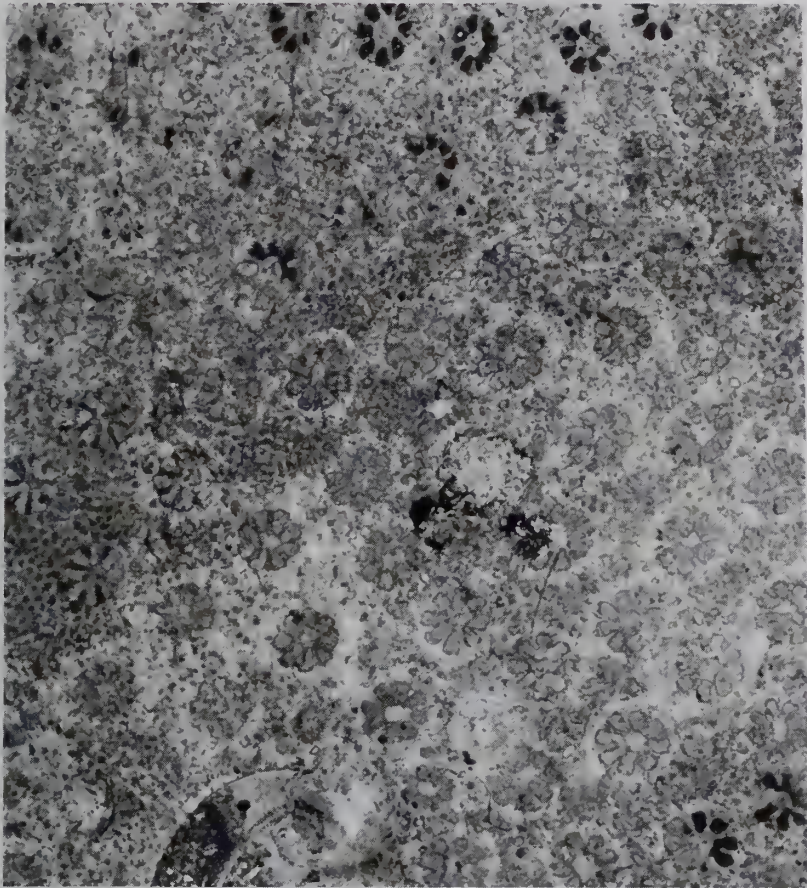
Micrographs of plocoid (1, 2), cerioid (4), and (hydno-phoro-) meandroid (3, 5) coral colonies in cross and transverse thin-sections.

Figs 1, 2 *Stylophora octophylla* (Felix, 1906); AZ 560.

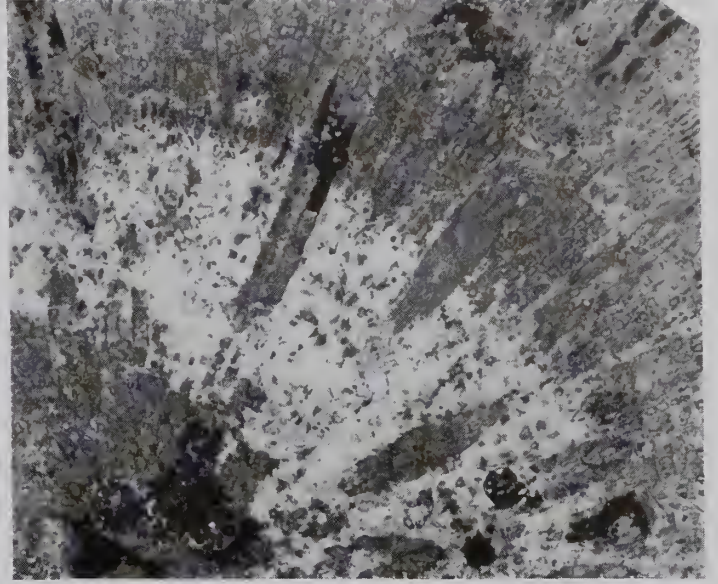
Figs 3, 5 *Moniculastraea insignis* Duncan, 1880; AZ 74.

Fig. 4 *Columactinastraea pygmaea* (Felix, 1903); AZ 541.

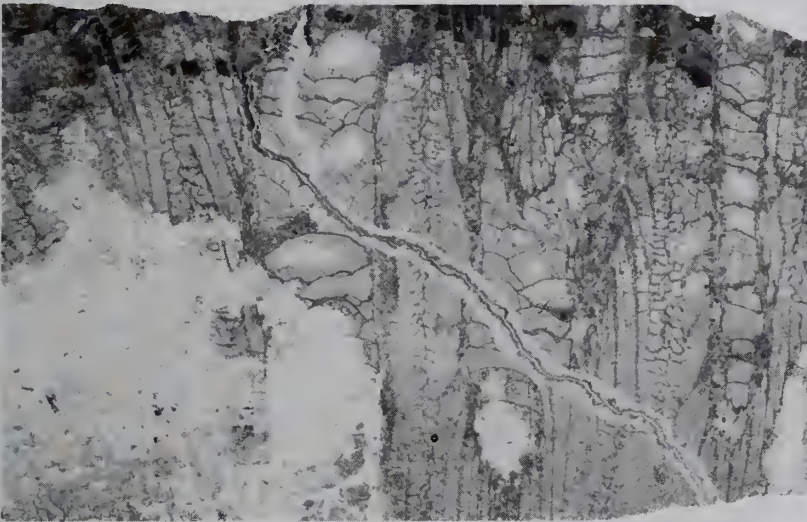
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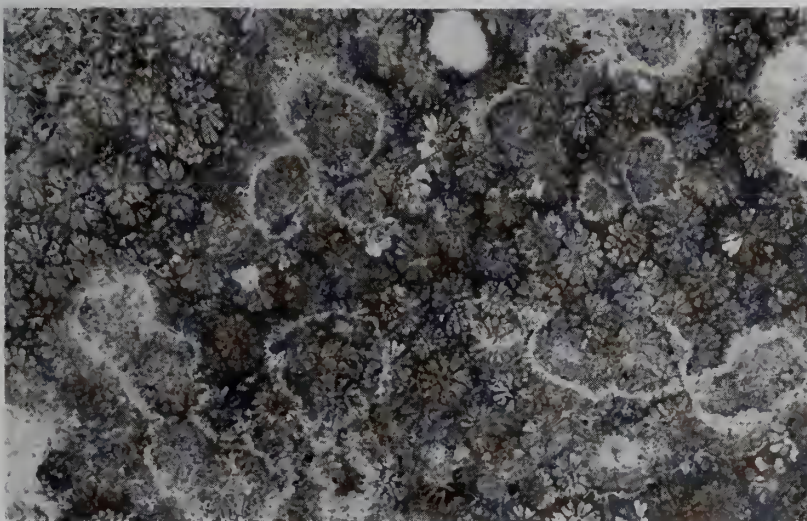
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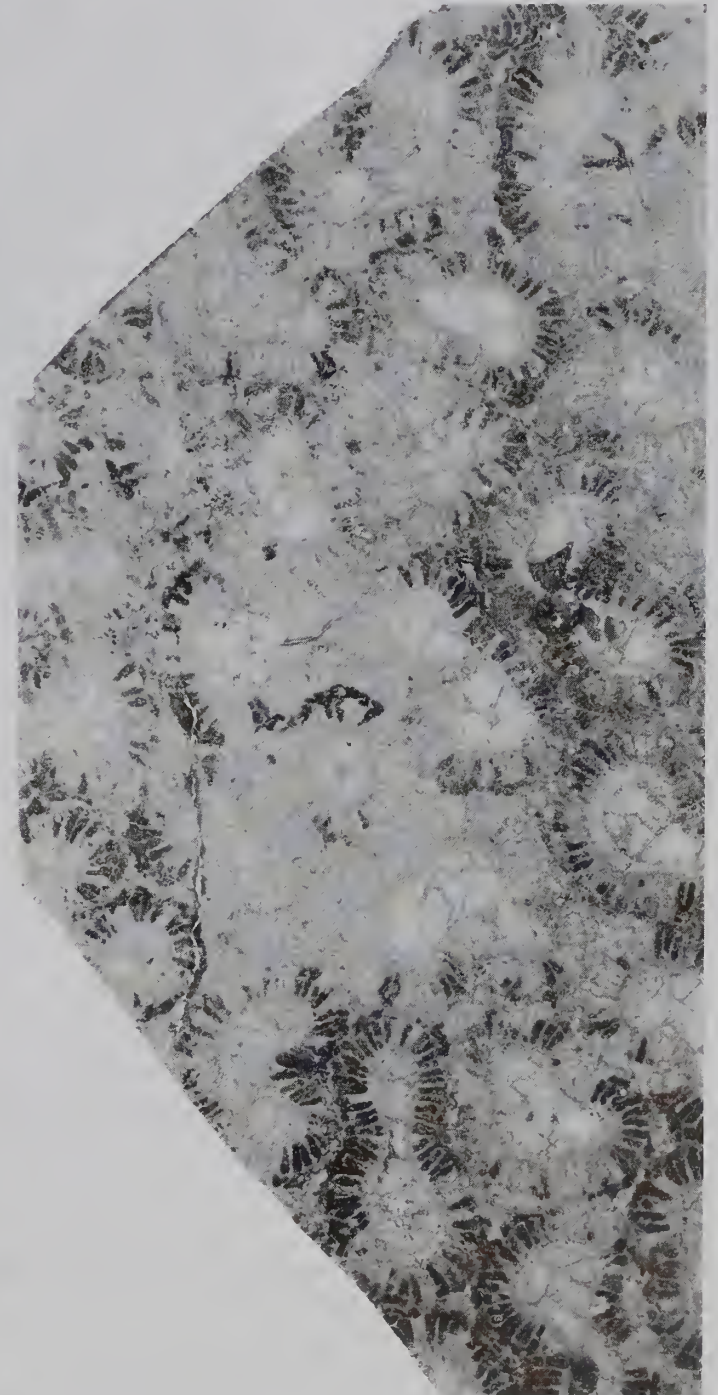
2



3



4



5

Stylophora octophylla (Felix, 1906)

Pl. 1, figs 1, 7, Pl. 2, figs 1, 2

*1906 *Astraeaopora octophylla* Felix: 44, pl. III, figs 6, ?6a.1911 *Actinacis* (?) *octophylla* (Felix); Trauth: 161.

MATERIAL. AZ 405; AZ 458; AZ 524; AZ 526; AZ 538; AZ 544; AZ 548; AZ 552; AZ 557; AZ 559; AZ 560.

MEASUREMENTS. d: 0.6–1.1 mm; c–c: 1–2.5 mm; s: 8 (*+s2); size of the colony: 2–10 cm in diameter.

DESCRIPTION. The corallum is irregularly massive or ramose and plocoid, with calices that are separated by a dense, granular coenosteum. Gemmation is due to extracalicular budding. Corallites are circular in outline. Costosepta are straight, nonconfluent, compact, and arranged in 1 cycle in 8 systems. In some calices a septal development in ?6 or ?7 systems is present. Septa might extend to, and fuse with, the columella. In a few calices the beginning of a second cycle can be observed. Septal flanks are covered by very delicate spiniform granules. Columella is styloform. Synapticulae are scattered throughout the colony. The wall is parathecal and synapticulothecal, with pores. Endotheca consists of numerous thin, subtabulate or slightly arched dissepiments. Exotheca is made of vesicular dissepiments.

REMARKS. In the specimen described by Felix (1906) the development of the trabecular and sponge-like coenosteum, together with the appearance of both an incomplete wall and a (?pseudo-) columella, suggests that it represents a form of *Stylophora* Schweigger. (Original description in Felix 1906: 44: '... Das Gewebe der Koralle besteht aus einem trabekulären Coenenchym, dessen einzelne Bälkchen durch querleistenartige Verdickungen und Synaptikeln verbunden werden. Die Oberfläche erscheint wie mit feinen, wirren Runzeln bedeckt bzw. hat eine große Ähnlichkeit mit dem Gewebe vieler Spongien. In diesem Coenenchym zerstreut liegen nun zahlreiche, kleine, rundliche Kelche. Ihre Mauer scheint nie kompakt zu werden, sondern stets unvollständig zu bleiben. Ihr Durchmesser beträgt meist 1 mm. In ihnen sieht man gewöhnlich 8 Septen, welche im Mittelpunkt zusammenstoßen pflegen, wodurch eine Art Pseudokolumella entsteht...').

OCCURRENCE. *Loftusia* Level (Beds 3–8), SW corner of Jebel Huwayyah, east of Al Ain; outcrop at southern tip of Jebel Faiyah (lowest 3 m of section, bed 2, base of bed 6), 6 km NNE of Al Madam; outcrop on east face, ca. 3 km north of the southern tip of Jebel Faiyah, NNE of Al Madam; loose from lowest 3–4 m of section at east face of most northern hill forming Jebel Buhays (beds 4–11), 4 km north of Al Madam.

DISTRIBUTION. Senonian of Slovakia and Romania.

Suborder FAVIINA Vaughan & Wells, 1943

Family FAVIIDAE Gregory, 1900

Subfamily FAVIINAE Vaughan & Wells, 1943

REMARKS. The systematic position of the genus *Monticulastraea*

Duncan has been discussed since the last century. Felix (1914) does not record it in his Fossilium Catalogus, Vaughan & Wells (1943) and Wells (1956) conceive this genus as a younger synonym of *Hydnophora* Fischer von Waldheim, Alloiteau (1952a, 1957) does not document this form, Gregory (1930) gives a short review of *Monticulastraea* and designates the type species. Recently, Bosellini (1999) compared Tertiary representatives of *Monticulastraea* Duncan and *Hydnophora* Fischer von Waldheim. She concluded that the skeletal elements in both forms are nearly identical, and therefore suggested that they are synonymous. However, the specimens at hand distinctly differ from Bosellini's model in that they have monticules consisting of coenosteum with large vesicular dissepiments forming an exothecal wall. The development of such skeletal structures exclude the forms from the genus *Hydnophora*, and supports the idea that *Monticulastraea* is not congeneric with *Hydnophora*. It seems necessary to investigate and compare more of those specimens from both Cretaceous and Tertiary strata to evaluate the pertinent taxonomical criteria (Bosellini & Baron-Szabo, in prep.).

The specimens from the UAE/ Oman closely agree with the generic conception by Duncan (1880), Gregory (1930), and Kühn (1933).

Genus *Monticulastraea* Duncan, 1880TYPE SPECIES. *Monticulastraea elongata* Duncan, 1880.*Monticulastraea insignis* Duncan, 1880

Pl. 2, figs 3, 5, Pl. 5, fig. 3

*1880 *Monticulastraea insignis* Duncan: 87, pl. XXVI, figs 1–3.1930 *Monticulastraea insignis* Duncan; Gregory: 96.1933 *Monticulastraea insignis* Duncan; Kühn: 194.

MATERIAL. AZ 62; AZ 74–75; AZ 84; AZ 294–97; AZ 461; AZ 540; AZ 656; AZ 2538.

MEASUREMENTS. d (series): 1.5–5 mm; maximum diameter of monticules: 2–9 mm; minimum diameter of monticules: 0.5–3 mm; s/ mm: 7–11/2; size of the colony: 6.5–12 cm in diameter.

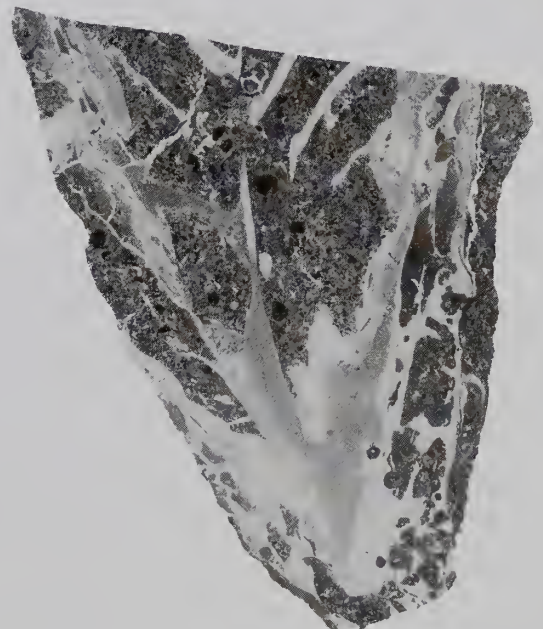
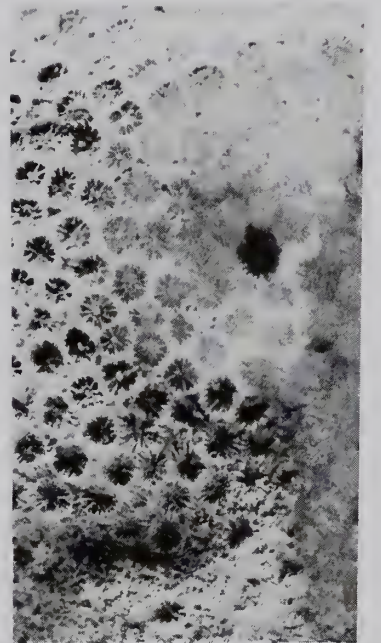
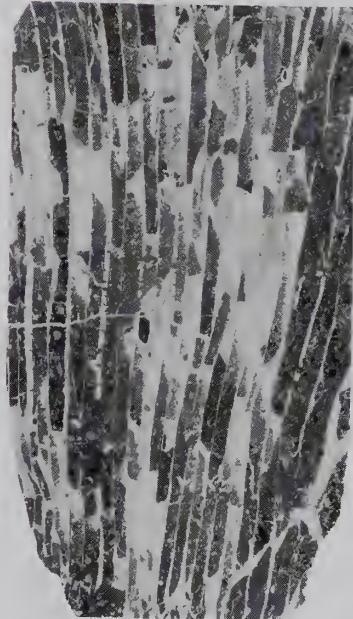
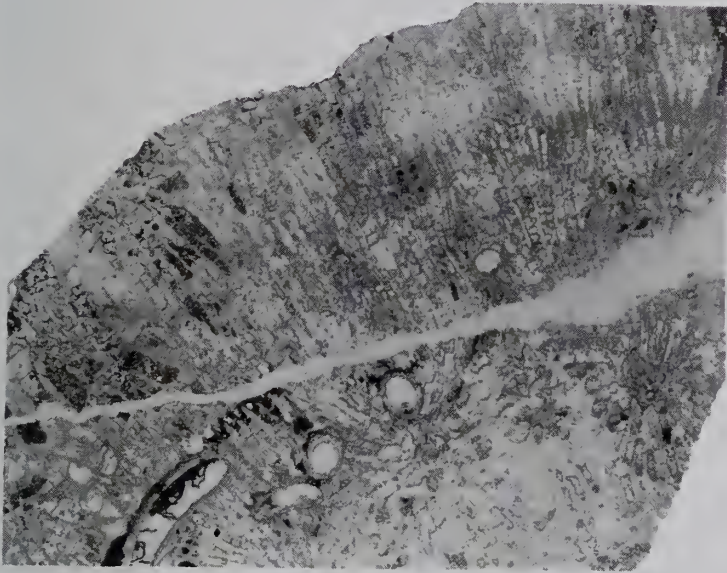
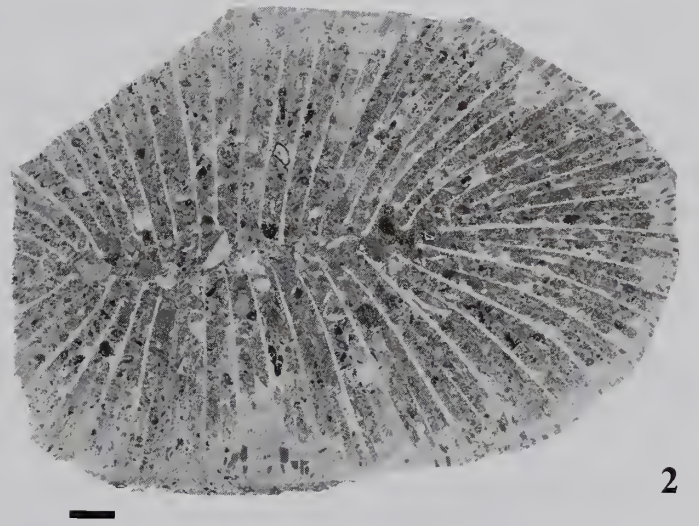
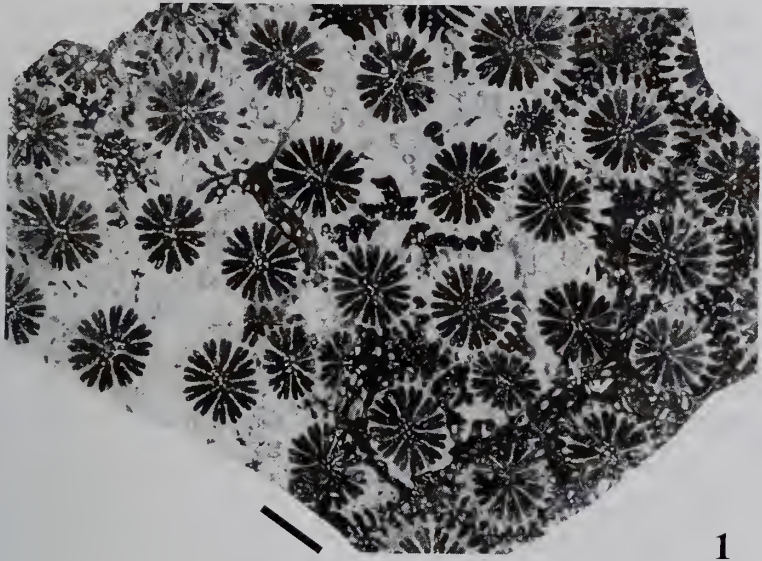
DESCRIPTION. The corallum is massive with corallites that are arranged in sinuous series defined by short tectiform monticules, consisting of coenosteum. Costosepta are compact, thin, straight, and arranged in two with a beginning third size orders. Septa of the first two orders extend to the centre of the series where their inner ends terminate in claviform thickenings or fuse with the columella. They slightly alternate in thickness. Septa of the third order are distinctly shorter and thinner. Septal flanks are covered with delicate spiniform granules. Columella is lamellar, thin, and continuous. The wall is septothecal. Endotheca consists of thin, tabulate or slightly arched dissepiments. Exotheca is made of large vesicular dissepiments. The microstructure is formed by simple minitrabeculae sometimes giving off secondary ones (septa), and simple or polyaxial minitrabeculae (wall).

PLATE 3

Micrographs of plocoid (1, 3, 5, 6) and turbinate (2, 4, 7) coralla in transverse and longitudinal thin-sections, and upper surface view.

Fig. 1 *Neocoenia lepida* (Reuss, 1854); AZ 479.Figs 2, 4, 7 *Montilivaltia* sp.; AZ 57.Figs 3, 6 *Stephanaxophyllia casterasi* Alloiteau, 1957; AZ 456.Fig. 5 *Columastrea dubia* Alloiteau, 1958; AZ 47.

Scale bar = 3 mm.



REMARKS. The specimens from the UAE/ Oman very closely agree with the description and illustration of the type material. The type species was designated by Gregory (1930: 96).

OCCURRENCE. Outcrop on east face, ca. 3 km north of southern tip of Jebel Faiyah, NNE of Al Madam; outcrop forming slope and cliff on north side of Jebel Bu Milh, 25 km NE of Hili (beds 3/4); east face of most northern hill forming Jebel Buhays, 4 km north of Al Madam; outcrop on south side of slope, 3 km east of Jebel Rawdah, east of Al Madam; outcrop at southern tip of Jebel Faiyah (base of bed 6), 6 km NNE of Al Madam.

DISTRIBUTION. Burdigalien-Upper Miocene of India (base of Gáj Group).

Family **HELIASTREIDAE** Alloiteau, 1952

Genus **NEOCOENIA** Hackemesser, 1936

TYPE SPECIES. *Neocoenia renzi* Hackemesser, 1936.

Neocoenia lepida (Reuss, 1854) Pl. 3, fig. 1

*1854 *Astrea lepida* Reuss: 114, pl. XII, figs 1, 2.

v1903a *Phyllocoenia lepida* (Reuss); Felix: 293.

1936 *Phyllocoenia lepida* (Reuss); Hackemesser: 19.

1978 *Neocoenia lepida* (Reuss); Turnšek, in Turnšek & Polšák: 153, 172, pl. 10, figs 1–3.

v1997 *Neocoenia lepida* (Reuss); Baron-Szabo: 64, pl. 5, figs 3, 4 (older synonyms are cited therein).

MATERIAL. AZ 413–14; 451; AZ 453; AZ 470; AZ 479; AZ 638; AZ 658; AZ 923; AZ 931.

MEASUREMENTS. d (lumen): 2.5–4 (*4.5) mm, juvenile: 1.5–2 mm; d: 3.5–4.5 (*5.5) mm, juvenile: 2.5 mm; c–c: (*3) 3.5–6.5 mm; s: 24 +s3, juvenile: 20; size of the colony: 5–13 cm in diameter.

DESCRIPTION. The corallum is in the form of a massive, plocoid colony with corallites that are circular in outline. Calices are regularly disposed on the surface of the colony. Costosepta are straight,

nonconfluent, compact, 24 in number, and arranged in three cycles and 6 systems. They regularly alternate in length. Septal flanks have spiniform granulations. Septa of the first cycle extend to, and may fuse with, the columella. The inner ends of first and second cycle septa can be slightly swollen. Paliform structures irregularly occur in front of S_1 and S_2 . Intercorallite areas are crossed by the costae when corallites are close together; when they are more distant, costae merge into a porous, reticulated coenosteum. The columella is variably developed: spongy-papillose, thin lamellar, or formed by a few twisted segments. The wall is parathecal, in places septoparathecal. Endotheca consists of thin vesicular or subtabulate dissepiments. Septal microstructure consists of simple mini- or medium-sized trabeculae.

REMARKS. According to Hackemesser (1936) the material from central Greece he investigated was determined as Cenomanian in age. Due to recent studies of the rudists at the same locality carried out by Th. Steuber, Erlangen, (pers. comm.) these deposits possibly represent a mixture of stratigraphically heterogeneous sediments (Aptian to Campanian). Therefore, in chapter on distribution mentioned here the age of the locality in Hackemesser (1936) is accompanied by a question mark (previously discussed in Baron-Szabo, 1998).

OCCURRENCE. Outcrop forming slope and cliff on north side of valley (beds 3, 10), 3 km east of Jebel Rawdah, east of Al Madam; SW corner of Jebel Huwayyah, east of Al Ain; east face of most northern hill forming Jebel Buhays, 4 km north of Al Madam; loose, derived from 3–4 m of section NE side of Jebel Buhays, 4 km north of Al Madam; Qahlah Formation, loose from *Loftusia* Beds, SE corner of Jebel Huwayyah, east of Al Ain; outcrop on east face, ca. 3 km north of the southern tip of Jebel Faiyah, NNE of Al Madam.

DISTRIBUTION. Cenomanian-Turonian of France, Cenomanian of Lebanon, ?Cenomanian of Greece, ?Upper Turonian-Lower Coniacian and Santonian-Campanian of Austria (Gosau Group), Santonian-Campanian of Hungary and Romania, Campanian of Serbia.

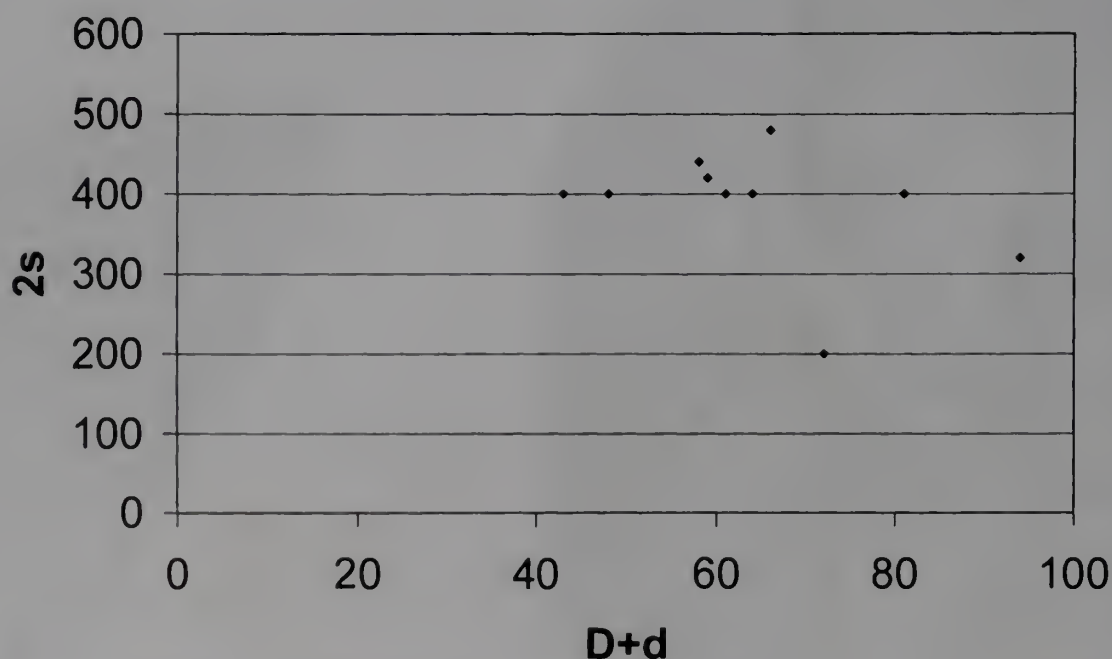


Fig. 5 Ratio of number of septa (2s) to the average diameter (D+d) for the specimens of *Montlivaltia* sp. The points are widely scattered suggesting that the population consists of several species.

Family **MONTLIVALTIIDAE** Dietrich, 1926Genus **MONTLIVALTIA** Lamouroux, 1821TYPE SPECIES. *Montlivaltia caryophyllata* Lamouroux, 1821.

REMARKS. The validity of species of *Montlivaltia* Lamouroux has been discussed for several decades (e.g. Lambelet, 1968; Turnšek, 1972; Errenst, 1990). According to studies on Upper Jurassic forms of *Montlivaltia* carried out by Lambelet (1968) the characteristics which have been used to establish new taxa are directly dependent on ecological features (e.g. deep or shallow calice: agitated or quiet water; shape of the corallum: soft or hard substrate, sedimentation rate, water movement). It seems necessary to revise the group and evaluate the pertinent taxonomical criteria. Therefore, the specimens here are not assigned to any species (see Fig. 5).

Montlivaltia sp.

Pl. 3, figs 2, 4, 7

MEASUREMENTS. Dimensions of skeletal elements of the specimens of *Montlivaltia*.

	D (max) mm	d (min) mm	d/D	h mm	s
AZ 57	59	35	0.59	50	160
AZ 79	46	35	0.76	30	200
AZ 481	42	30	0.71	65	100
AZ 71	40	24	0.60	55	200
AZ 33	37	29	0.78	25	240
AZ 80	36	25	0.70	30	200
AZ 54	35	24	0.69	35	210
AZ 68	30	28	0.93	45	220
AZ 78	27	21	0.78	30	200
AZ 83	27	16	0.59	25	200

DESCRIPTION. The corallum is turbinate, ceratoid, cuneiform, or trochoid, elliptical or nearly circular in outline. Septa are compact, thin, straight, and arranged in 5 complete cycles with the beginning of a sixth cycle, in 6 systems. Septa of the first two cycles can be nearly equal in length and thickness. They reach the centre of the corallite, circumscribing the calicular pit. Remaining cycles of septa regularly alternate in length and thickness. Septal flanks are covered by delicate rounded granules, frequently forming carinae. There is no columella. Endothecal dissepiments are numerous, subtabulate or vesicular. Microstructure is poorly preserved, but in places simple minitraculae, and compound mini- or medium-sized trabeculae are present.

OCCURRENCE. *Loftusia* Level, main coral bed (beds 3–8), SW corner of Jebel Huwayyah, east of Al Ain.

MATERIAL. See Dimensions above.

Family **COLUMASTREIDAE** Alloiteau, 1952Genus **STEPHANAXOPHYLLIA** Alloiteau, 1957TYPE SPECIES. *Stephanaxophyllia casterasi* Alloiteau, 1957.*Stephanaxophyllia casterasi* Alloiteau, 1957

Pl. 3, figs 3, 6

*1957 *Stephanaxophyllia casterasi* Alloiteau: 74, pl. 9, fig. 8.1982 *Stephanaxophyllia hofergrabenensis* Beauvais, tome I: 128, pl. X, fig. 5.

MATERIAL. AZ 456; AZ 478; AZ 480; AZ 535; AZ 880; AZ 964.

MEASUREMENTS. d (lumen): 2–3.5 mm, in late budding stages up to 6 mm; c–c: 3–5.5 mm; s (monocentric calices): 24–36; size of the colony: 2.5–8 cm in diameter.

DESCRIPTION. Massive or knobby, plocoid colony with calices that are elongated or elliptical in outline. Multiplication is due to extra- and intracalicular budding, resulting in monostomatous to tristomatous conditions. In areas of intensive gemmation the corallites might be polygonal in outline, appearing to be cerioid. Costosepta are compact, nonconfluent, rarely subconfluent, and developed in 3 complete cycles in 6 systems. In general, the beginning of a fourth cycle is present. Septa of the first two cycles slightly alternate in length and thickness. They reach the centre of the calice, where their inner ends may terminate in claviform swellings or dissociate to form paliform structures. Septa of the third cycle may reach nearly three-quarters the length of the oldest ones, occasionally fusing with S_1 or S_2 . Septa of the fourth cycle are about half the length of S_3 . Columella is papillose or formed by fused segments, resulting in a lamellar appearance. The wall is septothecal and parathecal, in places synapticulothecal, with lacunes. Endotheca consists of numerous thin, vesicular or subtabulate dissepiments. Exotheca is formed by subtabulate dissepiments.

REMARKS. In having synapticulothecal developments and showing intracalicular budding the specimens of the UAE/ Oman more closely correspond to the description of the type species of *Stephanaxophyllia* Alloiteau than to its generic concept given by Alloiteau (1957: 73), in which these characteristics are not mentioned. Moreover, in the description the budding mode is given as 'generally extracalicular', whereas the illustration of the type species (Alloiteau, 1957: pl. 9, fig. 8) shows a larger number of dicentric corallites, indicating the strong influence of intracalicular gemmation.

OCCURRENCE. Basal 3 m of Simsima Formation, Jebel Buhays; outcrop at southern tip of Jebel Faiyah ([bed 1] bed 2), NNE of Al Madam; 3 km east of Jebel Rawdah (unit 3), east of Al Madam; Simsima Formation (lowest bed in section), NE corner of Jebel Buhays, 4 km north of Al Madam; Qahlah Formation, *Loftusia* beds, east side of U-shaped Jebel, 10 km NE of Al Ain.

DISTRIBUTION. Santonian of Austria (Gosau Group), Upper Santonian of France.

Genus **COLUMASTREA** d'Orbigny, 1849TYPE SPECIES. *Astrea striata* Goldfuss, 1826.*Columastrea dubia* Alloiteau, 1958

Pl. 3, fig. 5

*1958 (?) *Columastrea dubia* Alloiteau: 186, pl. XXV, fig. 2, pl. XXXIII, fig. 3.

MATERIAL. AZ 47; AZ 507; AZ 512; AZ 554; AZ 898; AZ 916; AZ 925; AZ 927; AZ 936–37; AZ 966; AZ 2534.

MEASUREMENTS. d: 1.2–2.2 mm; dl: (*0.7) 1–1.6 mm; c–c: (*1) 1.5–2.2 mm; s: (*18) 24; size of the colony: 1–9 cm in diameter.

DESCRIPTION. The corallum is massive, knobby, and plocoid, with calices which are rounded or elongated in outline. Costosepta are compact, non- or subconfluent, and are arranged in 3 cycles in 6 systems. Septa of the first cycle reach the centre of the calice, where their inner ends may fuse with the columella or terminate in claviform swellings, which can dissociate to form paliform structures. Second cycle septa can be of the same length, alternating in thickness. Septa

of the third cycle reach about half the length, but are distinctly thinner. Lateral surfaces of septa are covered by delicate spiniform granules. Columella is styloform. The wall is septothecal. Endotheca consists of thin, vesicular dissepiments.

OCCURRENCE. SE corner of Jebel Huwayyah (bed 8, ?9), east of Al Ain; *Loftusia* Beds, Qahlah Formation, SE corner of Jebel Huwayyah, east of Al Ain; ; east face of northern hill forming Jebel Buhays, 4 km north of Al Madam; outcrop at southern tip of Jebel Faiyah, 6 km NNE of Al Madam; Qahlah Formation, east side of U-shaped Jebel, 10 km NE of Al Ain.

DISTRIBUTION. Upper Campanian of Madagascar.

Family **PLACOCOENIIDAE** Alloiteau, 1952

Genus **PARAPLACOCOENIA** Beauvais, 1982

TYPE SPECIES. *Placocoenia orbignyana* Reuss, 1854.

Paraplacocoenia orbignyana (Reuss, 1854) Pl. 4, fig. 1

- ?1850 *Phyllocoenia marticensis* d'Orbigny, tome II: 204.
- v*1854 *Placocoenia orbignyana* Reuss: 99, pl. 9, figs. 1, 2.
- 1857 ?*Cyphastraea orbignyana* (Reuss); Milne Edwards & Haime, tome II: 277.
- 1899 *Phyllocoenia excelsa* Fromentel; Söhle: pl. 10, fig. 1.
- v1903a *Placocoenia orbignyana* Reuss; Felix: 296, fig. 48.
- 1914 *Placocoenia orbignyana* Reuss; Felix, pars 7: 155.
- ?1914 *Phyllocoenia marticensis* d'Orbigny; Felix, pars 7: 158.
- ?1937 *Placocoenia orbignyana* Reuss; Bataller: 105.
- v1982 *Paraplacocoenia orbignyana* (Reuss); Beauvais, tome I: 114, pl. 9, figs. 1, 2 (older synonyms cited therein).
- v1999 *Paraplacocoenia orbignyana* (Reuss); Baron-Szabo: pl. 4, fig. 4, pl. 7, figs. 1–2, text-fig. 2.

MATERIAL. AZ 209–10; AZ 513; AZ 523; AZ 545; AZ 549–51; AZ 563; AZ 582; AZ 884; AZ 946–47; AZ 962–63.

MEASUREMENTS. d: 3–5.5 (*6.5) mm; dl: 2–3.5 (*4) mm; c–c: 2.5–6.5 (*7) mm; s: 24 + s3; size of the colony: 6–14 cm in diameter.

DESCRIPTION. Massive and plocoid corallum, with circular or slightly elliptical calices. Increase is by extracalicular budding. Costosepta are compact, nonconfluent, occasionally subconfluent, and arranged in 3 complete cycles in 6 regular systems. In some calices the beginning of a fourth cycle is present. Septa of the first cycle extend to the centre of the corallite. Their inner ends may be cuneiform, irregularly thickened, or may produce trabecular prolongations, which fuse with the columella. Second cycle septa are almost of the same length, but alternate in thickness. Septa of the third cycle regularly alternate in length and thickness. Youngest septa are distinctly thinner and shorter than the ones of the preceding cycle. Septal flanks are covered by rounded or spiniform granules. Intercorallite areas are crossed by costae, rarely dissociating into a reticulated coenenchyme. Columella is lamellar, short, thin, or rudimentary. Wall is septothecal, septoparathecal, and rarely ?synapti-

culothecal. Endotheca is formed by thin, vesicular and tabulate dissepiments. Exotheca consists of vesicular or cellular dissepiments.

REMARKS. Beauvais (1982) lists *Paraplacocoenia orbignyana* (Reuss) as a junior synonym of *Phyllocoenia marticensis*, but gives the first priority over the latter. Because the author has not seen the type of *Phyllocoenia marticensis*, *Paraplacocoenia orbignyana* (Reuss) is tentatively regarded as a primary species (previously discussed in Baron-Szabo, 1999). However, the Oman specimens very closely agree with the type material of *Paraplacocoenia orbignyana* (Reuss).

OCCURRENCE. *Loftusia* Beds, Qahlah Formation, east side of U-shaped Jebel, 10 NE of Al Ain; outcrop on east face, ca. 3 km north of the southern tip of Jebel Faiyah, NNE of Al Madam; *Loftusia* Beds, Qahlah Formation, SE corner of Jebel Huwayyah (beds 10/11), east of Al Ain; scree slope at SW corner of Jebel Buhays, 4 km north of Al Madam; outcrop at southern tip of Jebel Faiyah, 6 km NNE of Al Madam; NE slope of valley at Qarn Murrah, 15 km north of Al Madam; NE slope of valley at Qarn Murrah, 8 km west of northern tip of Jebel Faiyah, 15 km north of Al Madam.

DISTRIBUTION. Upper Cretaceous of southern France (Provence), Santonian of northeastern Spain (Catalonia), Santonian-Campanian of Austria (Gosau Group).

Genus **ASTROGYRA** Felix, 1900

TYPE SPECIES. *Gyrosmlia edwardsi* Reuss, 1854.

Astrogyra edwardsi (Reuss, 1854) Pl. 5, fig. 1, Pl. 6, fig. 4

- v*1854 *Gyrosmlia edwardsi* Reuss: 92, pl. IV, figs 1–3.
- 1857 *Thecosmlia ? edwardsi* (Reuss); Milne Edwards, tome II: 362.
- 1900 *Astrogyra edwardsi* (Reuss); Felix: 2.
- non 1930 *Astrogyra edwardsi* (Reuss); Oppenheim: 308, pl. XXXII, figs 5, 5a.
- 1937 *Astrogyra edwardsi* (Reuss); Bataller: 120, text-fig. 121.
- 1956 *Astrogyra edwardsi* (Reuss); Bendukidze: 91, pl. I, fig. 5, pl. VII, figs 8, 8a.
- 1982 *Astrogyra edwardsi* (Reuss); Beauvais, tome I: 78, pl. V, fig. 2 (older synonyms are cited therein).

MATERIAL. AZ 421; AZ 423–26; AZ 428; AZ 463; AZ 474–75; AZ 577; AZ 647; AZ 665; AZ 97–75.

MEASUREMENTS. d (series including peritheca): (*12) 18–25 (*30) mm; d (ambulacrum): 1–5 mm; s/mm: 10–18/10; size of the colony: 12–15 cm in diameter.

DESCRIPTION. The corallum is massive and meandroid, with corallites that are arranged in parallel, or wavy series. Series are united by perithecal walls, which are marked by ambulacrae. Costosepta are compact, non-confluent, thin, straight, and developed

PLATE 4

Micrographs of plocoid (1, 4), cerioid (2, 5) and branching phaceloid (3) coral colonies in transverse thin-sections.

Fig. 1 *Paraplacocoenia orbignyana* (Reuss, 1854); AZ 513.

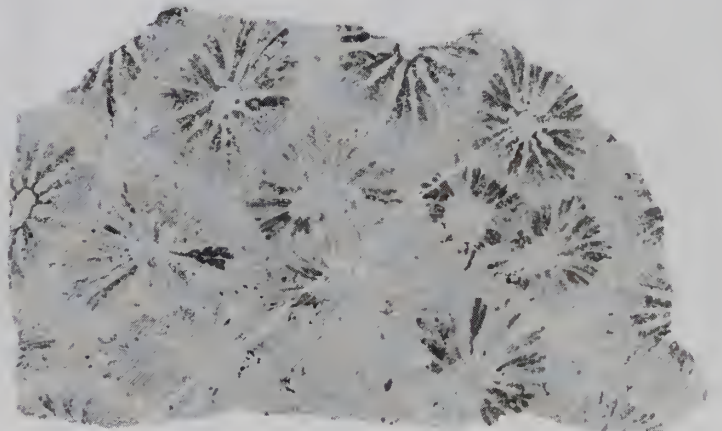
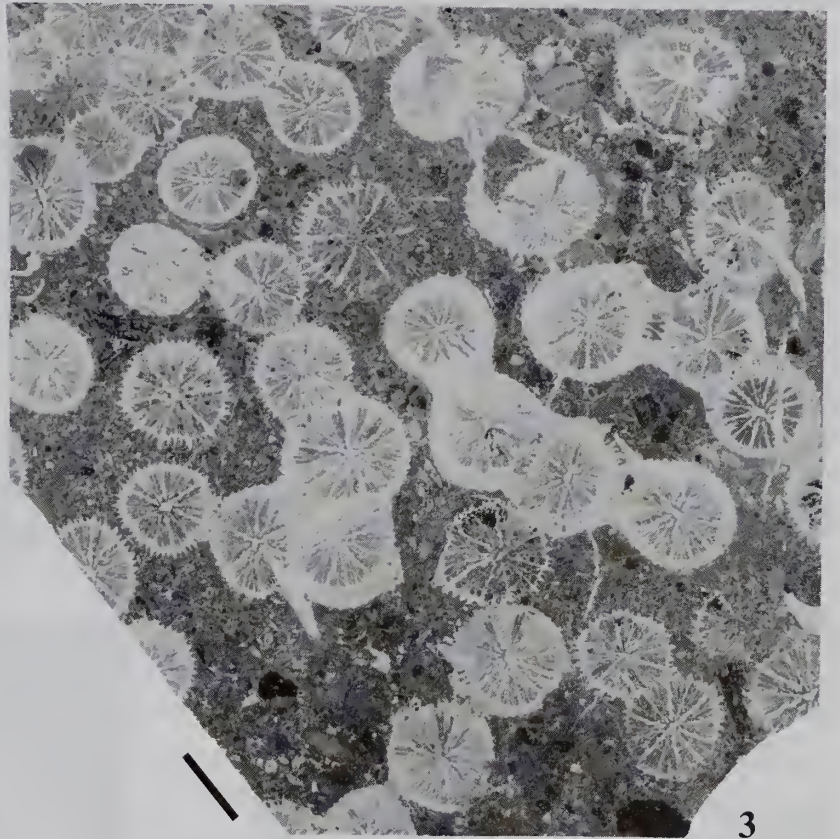
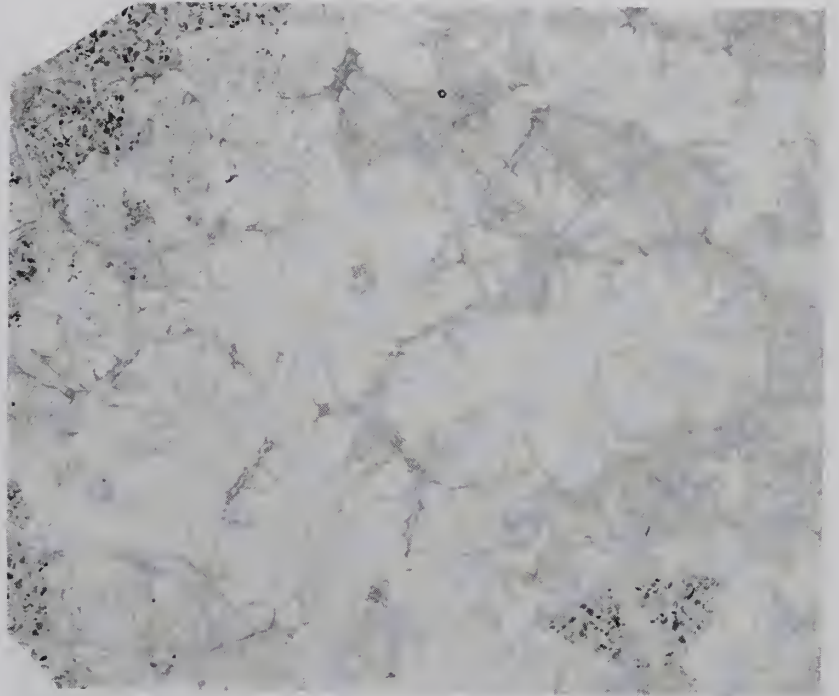
Fig. 2 *Glenarea cretacea* Pocta, 1887; AZ 429.

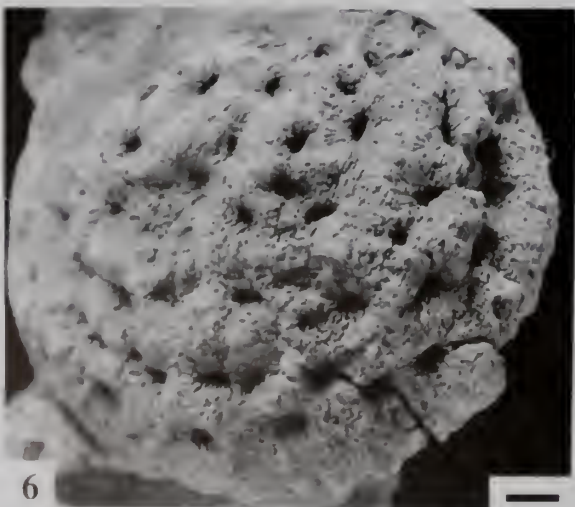
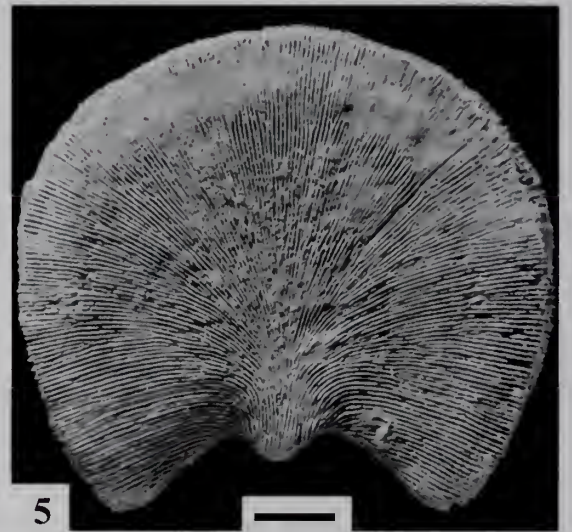
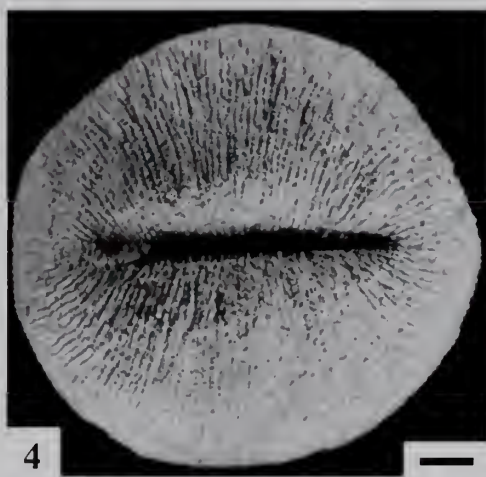
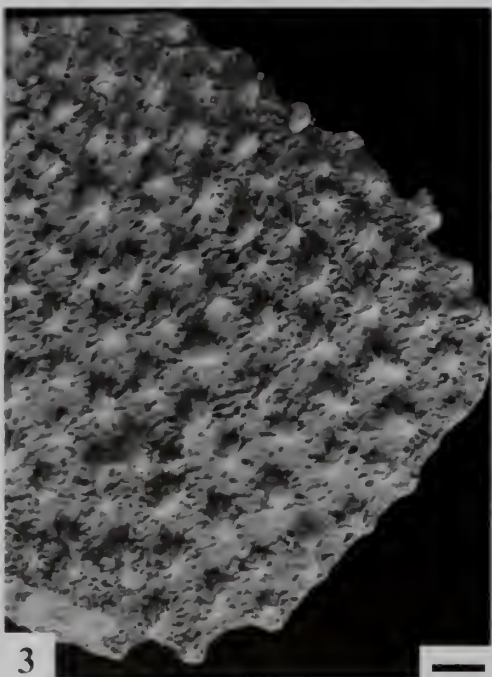
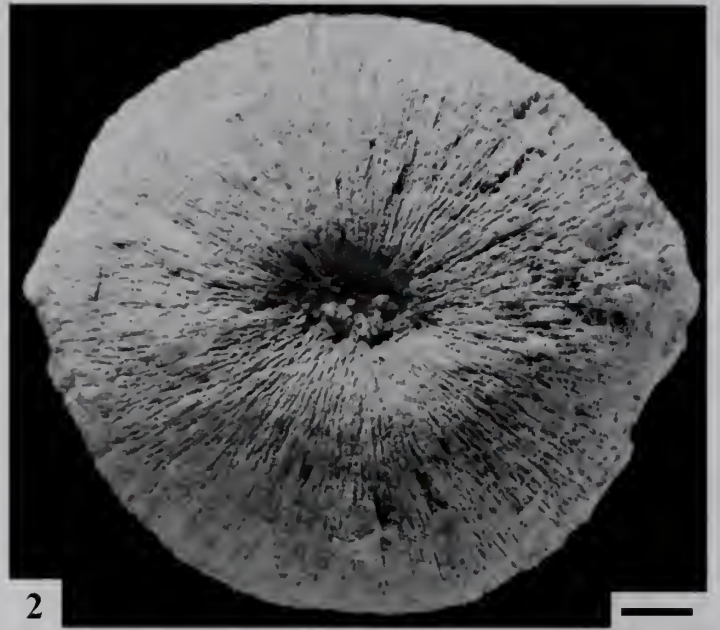
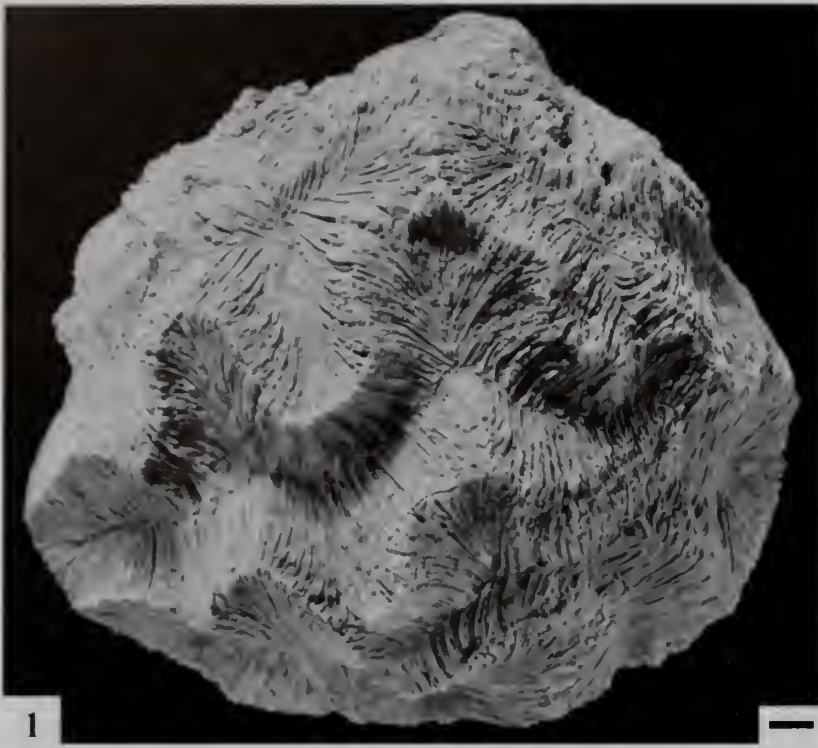
Fig. 3 *Cladophyllia stewartae* Wells, 1944; AZ 575.

Fig. 4 *Agathelia asperella* Reuss, 1854; AZ 895.

Fig. 5 *Diplocoenia* cf. *parvistella* Alloiteau, 1958; AZ 457.

Scale bar = 3 mm.





in 3 orders. In places the beginning of a fourth order is present. Septal flanks are finely granulated. Septa of the first two orders are of the same length, but differ in thickness. Their inner ends are rhopaloid or claviform. Trabecular prolongations of their inner ends may extend to, and fuse with, the columella. Septa of the third order reach about half the length of S1 and S2. Columella is lamellar, very thin and discontinuous. Endotheca consists of numerous vesicular or subtabulate dissepiments.

REMARKS. According to Beauvais (1982, tome I: 80) *Astrogyra edwardsi* (Reuss) in Oppenheim represents a younger synonym of *Astrogyra orbignyi* (Fromentel).

OCCURRENCE. *Loftusia* Levels, Beds 3–8, SW of Jebel Huwayyah; outcrop forming slope on north side of valley (beds 13, 15, 19), ca. 2 km east of Jebel Rawdah, east of Al Madam.

DISTRIBUTION. Upper Cretaceous of Romania, Senonian of Georgia (in Caucasia), Santonian of Austria (Gosau Group), Upper Santonian of northern Spain (Catalonia).

Family **PLACOSMILIIDAE** Alloiteau, 1952

Genus **PLACOSMILIA** Milne Edwards & Haime, 1848

TYPE SPECIES. *Turbinolia cymbula* Michelin, 1846.

Placosmilia sinuosa (Reuss, 1854) Pl. 6, fig. 5

*1854 *Euphyllia sinuosa* Reuss: 92, pl. XVI, fig. 3.

1857 *Thecosmilia* ? *sinuosa* (Reuss); Milne Edwards, tome II: 360.

1900 *Lasmogyra irregularis* Felix: 3.

1982 *Placosmilia sinuosa* (Reuss); Beauvais, tome I: 62, pl. III, fig. 3 (older synonyms cited therein).

MATERIAL. AZ 46; AZ 59; AZ 940.

MEASUREMENTS. d (max): 80–125 mm; d (min): 20–40 mm; s/ mm: 15–19/ 10; h: 4–9 cm.

DESCRIPTION. Flabelliform corallum, very elongate in outline. Costosepta are compact and straight, becoming wavy toward the axial region. Three size orders of septa irregularly alternate in length and thickness. In some parts the beginning of a fourth order is present. Septa of the first two orders reach the centre of the corallum. Their inner ends terminate in claviform or rhopaloid thickenings, giving off trabecular prolongations which may meet with both neighbouring septa or with the columella. Septal flanks are covered by delicate rounded granules. The columella is very thin, lamellar and discontinuous. Wall is parathecal-epicostate. In places an epithelial wall can be observed. Endotheca is made of vesicular dissepiments. Microstructure is poorly preserved. Occasionally, mini- to medium-sized trabeculae can be seen.

REMARKS. In the description of the type material of *Placosmilia sinuosa* (Reuss), Beauvais (1982, tome I: 62 and table 1) gives the minimum diameter ranging from 29.5 to 34.5 mm and the density of

septa of 10 in 10 mm. In contrast, the photograph of the type presented by Beauvais (1982, tome IV, pl. III, fig. 3) reveals the dimensions 19 up to around 40 mm for the minimum diameter and the density of septa of around 20 in 10 mm, thus completely agreeing with the original description by Reuss (1854: 92). Assuming that Beauvais' data represent printing errors, it can be stated that the specimens at hand very closely correspond with the Austrian material.

OCCURRENCE. Main coral bed, *Loftusia* levels (beds 7, 10/ 11), SW and SE corner of Jebel Huwayyah, east of Al Ain.

DISTRIBUTION. Upper Santonian of Austria (Gosau Group) and southern France (Corbières).

Family **ISASTREIDAE** Alloiteau, 1952

Genus **DIPLOCOENIA** Fromentel, 1857

TYPE SPECIES. *Diplocoenia mirabilis* Fromentel, 1857.

Diplocoenia cf. parvistella Alloiteau, 1958 Pl. 4, fig. 5

*1958 *Diplocoenia parvistella* Alloiteau: 159, pl. XI, fig. 2.

MATERIAL. AZ 457.

MEASUREMENTS. d (max): 2–4 (*5) mm; d (min): 2–3.5 mm; c–c: 2.5–4.5 mm; s: 28–48; size of the colony: about 5 cm in diameter.

DESCRIPTION. Massive cerioid or subplocoid colony with corallites that are polygonal, subcircular, or elliptical in outline. Gemmation is due to extra- and intracalicular budding. Calices are directly united by their walls (regions with cerioid development) or are separated by small scaled intercorallite areas (resulting in a subplocoid arrangement). Costosepta are compact, straight, and developed in 3 to 4 cycles in 6 systems. Septa of the first two cycles extend the centre of the corallite where their inner ends may terminate in irregular thickenings, sometimes fusing with the columella. Septa of the third cycle are distinctly thinner, reaching about three-quarters the length of the oldest ones. Septa of the fourth cycles are very thin and short. Lateral surfaces of the septa are covered by thick rounded or delicate spiny granules. The columella is well-developed styliform to substyliform, or irregularly trabecular. Wall is parathecal, in places ?septotheal.

REMARKS. The calicular diameter in specimen of the UAE/ Oman is slightly larger than in *Diplocoenia parvistella* Alloiteau, but otherwise agrees well with it.

OCCURRENCE. Basal 3 m of Simsima Formation, east face of most northern hill forming Jebel Buhays, 4 km north of Al Madam.

DISTRIBUTION. Coniacian of Madagascar.

Family **DERMOSMILIIDAE** Koby, 1889

Genus **CALAMOPHYLLIOPSIS** Alloiteau, 1952

TYPE SPECIES. *Calamophyllia flabellata* Fromentel, 1861.

PLATE 5

Micrographs of meandroid (1), flabello-meandroid (5, 7), (hydno-phoro-) meandroid (3), thamnasterioid (6), and discoid (2, 4) coralla in upper surface view.

Fig. 1 *Astrogyra edwardsi* (Reuss, 1854); AZ 975.

Figs 2, 4 *Cunolites* sp.; 2, AZ 400; 4, AZ 865.

Fig. 3 *Monticulastraea insignis* Duncan, 1880; AZ 656.

Figs 5, 7 *Diploctenium lunatum* (Bruguière, 1792); 5, AZ 2526; 7, AZ 328.

Fig. 6 *Aspidastraea orientalis* Kühn, 1933; AZ 189.

Scale bar = 3 mm.

Calamophylliopsis simonyi (Reuss, 1854) Pl. 9, fig. 4

- v*1854 *Cladocora simonyi* Reuss: 112, pl. XII, figs 5–7.
 1857 *Cladocora ? simonyi* Reuss; Milne Edwards, tome II: 598.
 1861 *Cladocora ? simonyi* Reuss; Fromentel: 150.
 v1903a *Cladocora simonyi* Reuss; Felix: 266, text-fig. 33.
 1914 *Cladocora simonyi* Reuss; Felix, pars 7: 171.
 1930 *Cladocora simonyi* Reuss; Oppenheim: 360.
 non 1976 *Procladocora simonyi* (Reuss); Turnšek, in Turnšek & Buser: 56, 79, pl. 12, figs 1, 2.
 non 1978 *Procladocora simonyi* (Reuss); Turnšek, in Turnšek & Polšak: 151, 171, pl. 7, figs 1–7.
 1982 *Calamophylliopsis simonyi* (Reuss); Beauvais, tome II: 233, fig. 2.

MATERIAL. AZ 580.

MEASUREMENTS. d (adult): 5–8 mm; d (juvenile): 3–4; s: 36–52; size of the colony: 13 cm in diameter.

DESCRIPTION. The corallum is in the form of a phaceloid colony with circular or slightly elliptical corallites. Costosepta are compact with rare perforations, thin, straight, and are generally arranged in 4 complete cycles in 6 systems. Septa of the first cycle reach the centre of the corallite, where trabecular prolongations of their inner ends may join or fuse with the columella. Second and third cycle septa can be nearly equal in length and thickness. Youngest septa are distinctly thinner and shorter. Lateral surfaces of septa are covered with delicate spiniform and rounded granules. Occasionally, synapticulae can be seen. The columella is parietal, well-developed. Wall is septoparathecal. Endotheca consists of thin subtabulate dissepiments. An epithecal wall is always present. Microstructure is poorly preserved, but in places simple minitraculae are present (wall and septa), forming wavy axial lines.

OCCURRENCE. Main coral bed (*Loftusia* levels, bed 7), SW corner of Jebel Huwayyah, east of Al Ain.

DISTRIBUTION. Santonian of Austria (Gosau Group).

Suborder **STYLININA** Alloiteau, 1952

Family **AGATHELIIDAE** L. & M. Beauvais, 1975

Genus **AGATHELIA** Reuss, 1854

TYPE SPECIES. *Agathelia asperella* Reuss, 1854.

Agathelia asperella Reuss, 1854 Pl. 4, fig. 4

- v*1854 *Agathelia asperella* Reuss: 82, pl. IX, figs 10–12.
 v1903a *Agathelia asperella* Reuss; Felix: 262, text-figs 30, 32.
 1926 *Agathelia urgonica* Dietrich: 75, pl. V, fig. 1, pl. VIII, fig. 2.
 ?1937 *Agathelia asperella* Reuss; Bataller: 141.
 v1975 *Agathelia asperella* Reuss; L. & M. Beauvais: 567, text-fig. 1, fig. 2, text-fig. 2, figs 1, 2.

- v1982 *Agathelia asperella* Reuss; Beauvais, tome I: 44, pl. LXI, fig. 7, pl. LXII, figs 1, 2.
 1987 *Agathelia asperella* Reuss; Kuzmicheva: 81, pl. II, fig. 1.
 v1989 *Agathelia asperella* Reuss; Höfling: 55.
 v1992 *Agathelia asperella* Reuss; Eliášová: 405, pl. VI, fig. 1.
 1994 *Agathelia asperella* Reuss; Liao & Xia: 69, pl. V, text-figs 43a–c.
 v1997 *Agathelia asperella* Reuss; Baron-Szabo: 35, pl. 1, figs 1, 3, 5 (older synonyms cited therein).
 1997 *Agathelia asperella* Reuss; Eliášová: 246 ff.

MATERIAL. AZ 434; AZ 520; AZ 895; AZ 899; AZ 950.

MEASUREMENTS. d: 3.5–6 mm; d (juvenile): 1.5–2.5 mm; dl: 2.5–4.5 mm; c–c: (*2.5) 3–5.5 mm; s: 24–48 +s5; s (juvenile): 16–22; size of the colony: up to 13 cm in diameter.

DESCRIPTION. Massive and plocoid colony with calices that are subcircular or elliptical in outline. Multiplication is due to extracalicular budding. Costosepta are compact, thin, straight, and arranged in 3 to 4 cycles in 6 systems. In some calices the beginning of a fifth cycle is present. Septa of the first two cycles are nearly equal in length and thickness, slightly alternating. They extend to the centre of the corallite, where their inner ends may terminate in claviform thickenings. Septa of the third and fourth cycle are distinctly thinner and reach about half the length of the ones of the preceding cycle. Their inner ends are cuneiform or stretch out forming auriculae. Lateral surfaces of septa are covered with spiniform and rounded granules, sometimes appearing as vertical subcarinae. The columella is lamellar, discontinuous in some calices. The wall is septothecal, in places parathecal. Endothecal dissepiments are thin and slightly arched. Exotheca consists of large vesicular dissepiments. Septal microstructure corresponds to the stylinid type illustrated in Roniewicz (1996), with medium to thick main trabeculae giving off secondary ones. The wall is formed by densely packed polyaxial trabeculae, with predominantly thick centres of calcification.

OCCURRENCE. East face of most northern hill forming Jebel Buhays, 4 km north of Al Madam; outcrop forming east face, ca. 3 km north of southern tip of Jebel Faiyah, NNE of Al Madam; coral/stromatoporoid level (bed 4), ca. 3 km east of Jebel Rawdah, east of Al Madam; *Loftusia* beds (bed 5), SE corner of Jebel Huwayyah, east of Al Ain.

DISTRIBUTION. Hauterivian of the Crimea, Barremian-Aptian of Tanzania, Albian-Cenomanian of Tibet, Upper Cenomanian-Lower Turonian of the Czech Republic, ?Upper Turonian-Lower Coniacian and Santonian-Campanian of Austria (Gosau Group), Santonian of Armenia, Santonian-Campanian of Slovakia, ?Maastrichtian of northern Spain.

Family **CLADOPHYLLIIDAE** Morycowa & Roniewicz, 1990
 Genus **CLADOPHYLLIA** Milne Edwards & Haime, 1851

TYPE SPECIES. *Lithodendron dichotomum* Goldfuss, 1826.

PLATE 6

Micrographs of solitary (1, 2), meandroid (4), flabello-meandroid (5), branching phaceloid (3) coralla in transverse thin-sections and upper surface view.

Fig. 1 *Aulosmilia aspera* (Sowerby, 1831); AZ 56.

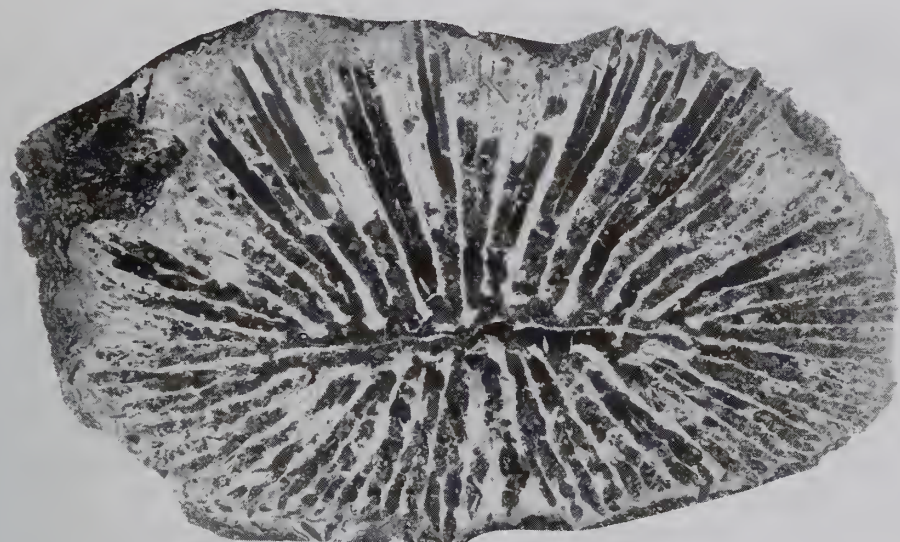
Fig. 2 *Phragmosmilia lineata* (Goldfuss, 1826); AZ 60.

Fig. 3 *Cladophyllia stewartae* Wells, 1944; AZ 643.

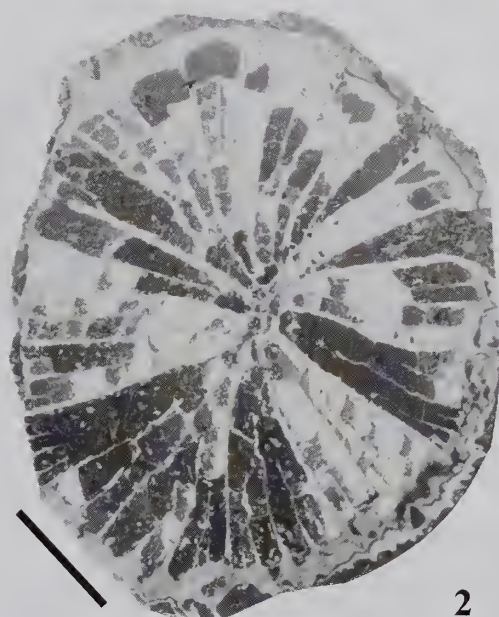
Fig. 4 *Astrogyra edwardsi* (Reuss, 1854); AZ 421.

Fig. 5 *Placosmilia sinuosa* (Reuss, 1854); AZ 59.

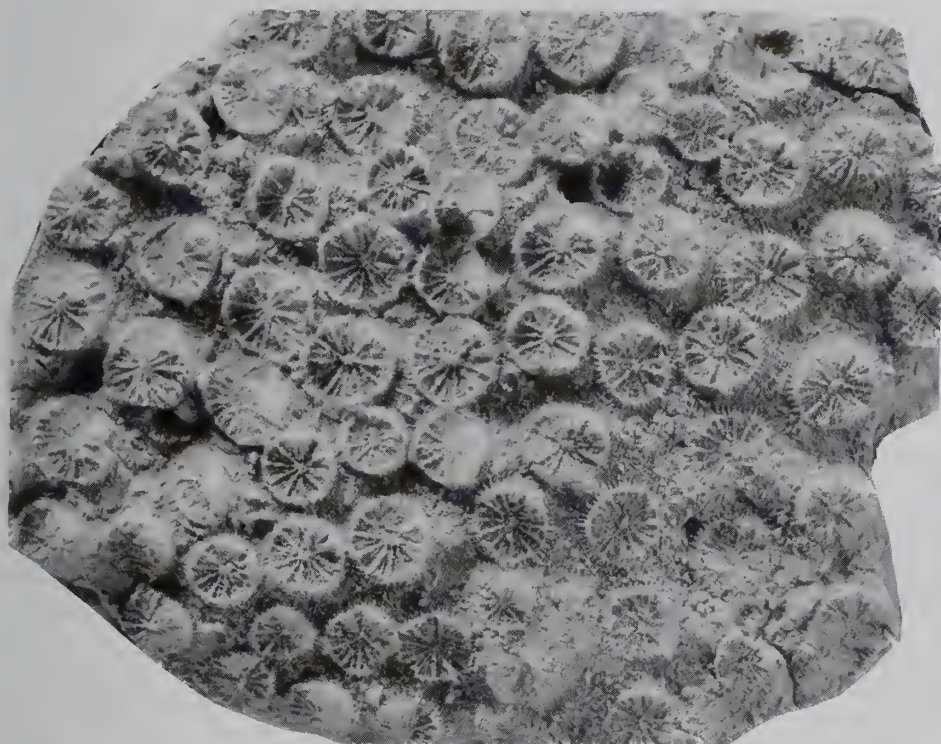
Scale bar = 3 mm.



1



2



3



5



4



Fig. 6 Stages of corallite division in *Cladophyllia minor* Beauvais, 1975, upon which the model of 'septal division' was established by Morycowa & Roniewicz (1990): 1 = initial stage characterized by fusion of septa; 2 = advanced stage with new septa on the wall surface developed; 3 = late stage with median wall line marked and a constriction developing between two corallites. Scale bar = 2 mm.

Cladophyllia stewartae Wells, 1944 Pl. 4, fig. 3, Pl. 6, fig. 3

*1944 *Cladophyllia stewartae* Wells: 442, pl. 74, figs 2, 3.

1990 *Cladophyllia stewartae* Wells; Morycowa & Roniewicz: 168.

MATERIAL. AZ 375; AZ 575; AZ 579; AZ 643; AZ 973.

MEASUREMENTS. d: (*2.5) 3–4 mm; s: 24 (*+s_d); size of the colony: up to 17 cm in diameter.

DESCRIPTION. The corallum is phaceloid, with corallites that are circular or slightly elongated in outline and having a diameter of 3 mm on average. Budding is due to 'septal division' (*sensu* Morycowa & Roniewicz, 1990; see Fig. 6). Costosepta are compact, straight, with lateral surfaces that are covered by sharply pointed or rounded granules, and are arranged in 3 complete cycles in 6 systems. Frequently, the beginning of a fourth cycle is present. Septa of the first two cycles reach the centre of the calice, where their inner ends may fuse. A trabecular, styliform, or sublamellar columella can be free or joined with oldest septa. Septa of the third cycle are distinctly thinner, reaching about three-quarters the length of the oldest ones. Youngest septa are very small and thorn-like. Anastomosis can be observed frequently. The wall is septothecal. Endotheca is made of tabulate dissepiments in the axial part of the corallite. In the peripheral region of the calice large vesicular dissepiments occur. Septal microstructure consists of simple minitraculae, forming dark axial lines.

REMARKS. In having a calicular diameter of 3 mm on average with a septal development of 3 cycles in 6 systems, and the first two septal cycles being nearly equal, the UAE/ Oman specimens closely agree with *Cladophyllia stewartae* Wells.

OCCURRENCE. *Loftusia* level, main coral bed (bed 7), SW corner of Jebel Huwayyah, east of Al Ain.

DISTRIBUTION. Upper Aptian-Lower Albian of Venezuela.

Suborder MEANDRIINA Alloiteau, 1952
Family DENDROGYRIIDAE Alloiteau, 1952
Genus DIPLOCTENIUM Goldfuss, 1826

TYPE SPECIES. *Diploctenium cordatum* Goldfuss, 1826.

Diploctenium lunatum (Bruguière, 1792) Pl. 5, figs 5, 7

*1792 *Madrepora lunata* Bruguière, tome I: 461, pl. 24, figs. 5–6.

1826 *Diploctenium cordatum*: Goldfuss (pars): 105, pl. XXXVII, fig. 16.

1849 *Diploctenium lunatum* (Bruguière); Milne Edwards & Haime, 3e sér., tome X: 248.

1851 *Diploctenium lunatum* (Bruguière); Milne Edwards & Haime: 50.

1863 *Diploctenium lunatum* (Bruguière); Fromentel: 248, pl. XIV, fig. 3.

1892 *Diploctenium lunatum* (Bruguière); Mallada: 160.

v1903a *Diploctenium lunatum* (Bruguière); Felix: 347, fig. 65.

1930 *Diploctenium angusterimatum* (Bruguière); Oppenheim: 533, pl. XLI, figs 10, 10a.

1937 *Diploctenium lunatum* (Bruguière); Bataller: 243.

1941 *Diploctenium lunatum* (Bruguière); Alloiteau: 51, pl. XXI, figs 1–3.

1952b *Diploctenium lunatum* (Bruguière); Alloiteau: 542, fig. 4.

1965 *Diploctenium lunatum* (Bruguière); Bendukidze: 20–24, pl. 2–4.

1982 *Diploctenium lunatum* (Bruguière); Beauvais, tome I: 164–167 (older synonyms cited therein).

v1998 *Diploctenium lunatum* (Bruguière); Baron-Szabo: 143, pl. 7, fig. 3.

?v1999 *Diploctenium* sp.; Baron-Szabo: pl. 6, figs 1–2.

MEASUREMENTS. Height of corallum from stem to upper surface (st): 17–28 mm; height of corallum from the extremities to upper surface (e): 12–46 mm; d (min): 3–9 mm; d (max): 20–42 mm; s/mm: 12–15/5.

Measurements (in mm) of the skeletal elements:

	st	e	d (max)	d (min)
AZ 503	28	46	40	4–5
AZ 739	25	26	39	7–9
AZ 328	24	30	35	5–7
AZ 204	23	?26	42	4.5–5.5
AZ 318	23	25	32	6–8
AZ 317	22	25	32	6–7
AZ 2526	21	24	26	3–4
AZ 738	20	23	23	5–7
AZ 316	20	12	?	5–6
AZ 437	19	16	25	3.5–6
AZ 633	18	20	26	3–5.5
AZ 319	?18	14	20	4–7
AZ 493	17	37	35	3.5–6.5

DESCRIPTION. The corallum is flabelliform, elongate, elliptical, or arched so strongly that the extremities of its longer axis may descend below the stem. Costosepta are compact, straight, and developed in

two orders with an incomplete third order. Septa of the first order extend to, and may fuse with, the columella. Septa of the second order are nearly equal in thickness, but slightly alternating in length. S3 are much thinner and may reach about one to three-quarters the length of the oldest ones. Septal flanks are covered with delicate spiniform granules. Inner ends of septa can be slightly thickened. The columella is thin, lamellar and discontinuous. The endotheca consists of thin dissepiments. The wall is septothecal.

REMARKS. Bendukidze (1956, 1965) studied the stages of ontogeny of specimens of *Diploctenium lunatum* (Bruguière). She concluded that skeletal elements and their dimensions in this species are directly dependent upon environment. Moreover, within the same specimen each stage of ontogeny closely corresponds to a different species of *Diploctenium*. These results completely disagree with the generic concept proposed by Alloiteau (1952a, b) (see also discussion in Beauvais 1982, tome I: 164 ff.). It seems necessary to investigate more specimens of different species of this genus to evaluate the pertinent taxonomical criteria. Specimens at hand closely agree with the descriptions and illustrations of *Diploctenium lunatum* by Bendukidze (1956, 1965) (previously discussed in Baron-Szabo, 1998).

Details closely agreeing with the septal development in the UAE/Oman specimens have been previously well illustrated (Baron-Szabo, 1999: pl. 6, fig. 1).

OCCURRENCE. *Trigonia/Pachymyra* Bed, east of Jebel Rawdah, east of Al Madam; east face of most northern hill forming Jebel Buhays, 4 km north of Al Madam (loose from beds 4–11); Simsima Formation, 3 km east of Jebel Rawdah, east of Al Madam; above *Zuffardia* level (bed 13), north side of valley, ca. 2 km east of Jebel Rawdah, east of Al Madam; north side of valley, ca. 3 km east of Jebel Rawdah, east of Al Madam.

DISTRIBUTION. Upper Cretaceous of Romania, Santonian-Campanian of Austria (Gosau Group), Turonian and Santonian-Maastrichtian of northern Spain (Catalonia), Upper Santonian of southern France (Provence and Corbières).

MATERIAL. See list in Measurements above.

Family **MEANDRIIDAE** Alloiteau, 1952

Subfamily **MEANDRIINAE** Vaughan & Wells, 1943

Genus **AULOSMILIA** Alloiteau, 1952

TYPE SPECIES. *Trochosmilia archiaci* Fromentel, 1867.

Aulosmilia aspera (Sowerby, 1832) Pl. 6, fig. 1

*1832 *Turbinolia aspera* Sowerby, in Sedgewick & Murchison: 417, pl. 37, fig. 1.

1857 *Montlivaultia rudis* Milne Edwards, vol. II: 314 (pars).

1863 *Placosmilia arcuata* Milne Edwards & Haime; Fromentel: 219, pl. 19, figs 1–4.

1914 *Trochosmilia chondrophora* Felix; Felix, pars 7: 213 (pars).

1974 *Aulosmilia aspera* (Sowerby); L. & M. Beauvais: 485.

1978 *Aulosmilia aspera* (Sowerby); Turnšek: 72, 104, pl. 3, figs. 1–4.

1982 *Aulosmilia aspera* (Sowerby); Beauvais, tome I: 218, pl. 18, fig. 6, pl. 19, fig. 2.

1987 *Aulosmilia aspera* (Sowerby); Kuzmicheva: 61.

v1998 *Aulosmilia aspera* (Sowerby); Baron-Szabo: 139, pl. 3, fig. 5, text-fig. 4.

v1999 *Aulosmilia aspera* (Sowerby); Baron-Szabo: pl. 6, fig. 5.

MATERIAL. AZ 50; AZ 55–56; AZ 73; AZ 795.

MEASUREMENTS. d (max) (D): 20–37 mm; d (min) (d): 13–27 mm; s: 120–140; h: 20–55 mm; d/D: 0.70–0.80.

DESCRIPTION. The corallum is simple, turbinate or ceratoid, elongated in outline. Costosepta are compact, thin, long, and arranged in 4 size orders, regularly alternating in thickness. Twenty to 24 septa reach the centre of the corallite, where they become slightly curved or flexuous. Their inner ends are cuneiform or terminate into claviform thickenings. Septa of the second order, being 20–24 in number, are distinctly thinner, but can be nearly of the same length. The third order consists of about 20 septa, which are very thin, reaching about half to three-quarters the length of septa of the preceding order. Septa of following orders are very short and thin. Columella is lamellar, thin and wavy. Endotheca consists of vesicular dissepiments, which mainly occur in the peripheral region of the corallum. The wall is septothecal. In places an epithelial wall is present.

REMARKS. The specimens from UAE/Oman very closely agree with the Campanian material of northern Spain (Baron-Szabo, 1998: 139, text-fig. 4). In coralla showing stages of rejuvenation the number of septa forming an order may be slightly larger (around 30), and the ratio d/D may be slightly smaller than the above given (0.62).

OCCURRENCE. *Loftusia* Level, Main Coral Bed (beds 3–8), SW corner of Jebel Huwayyah, east of Al Ain.

DISTRIBUTION. (?Upper Turonian-) Lower Coniacian-Santonian of Austria (Gosau Group), Middle Coniacian and Upper Santonian of southern France (Corbières, Provence), Santonian-Campanian of northwestern Croatia and Slovenia, Campanian of northern Spain.

Genus **GLENAREA** Pöcta, 1887

TYPE SPECIES. *Glenarea cretacea* Pöcta, 1887.

Glenarea cretacea Pöcta, 1887 Pl. 4, fig. 2

*1887 *Glenarea cretacea* Pöcta: 25, text-figs 9, 10.

non 1974 *Glenarea cretacea* Pöcta; Turnšek, in Turnšek & Buser: 20, 100, pl. 10, fig. 2.

v1991 *Glenarea cretacea* Pöcta; Eliášová: 99, pl. I, figs 1a, b.

1997b *Glenarea cretacea* Pöcta; Eliášová: 258.

MATERIAL. AZ 285; AZ 429–30; AZ 543.

MEASUREMENTS. d (max): 2.5–7 mm; d (min): 1.5–4.5; s: 12–24, s/mm: 3–4/ 2; size of the colony: 6–7 cm in diameter.

DESCRIPTION. The corallum is massive, hemispherical and cerioid, with corallites directly united by their walls and are polygonal or slightly rounded in outline. Gemmation is due to intracalicular budding, which resembles the 'septal division' in its early stage (*sensu* Morycowa & Roniewicz, 1990; see Fig. 6). Costosepta are compact, straight, thin, nonconfluent, nearly equal in thickness, and are radially arranged in two to three cycles in 6 systems. In corallites which are influenced by gemmation a bilateral or irregular septal development is present. Four to 12 septa reach the axial region, where their inner ends may extend to, and fuse with, the columella or neighbouring septa. First and second cycle septa can be nearly equal in length. Remaining septa regularly alternate in length. Anastomosis is seen frequently. Septal flanks are finely granulated. The columella is short, lamellar. Wall is septothecal and septoparathecal. Endotheca consists of thin vesicular dissepiments. Microstructure is poorly preserved, but in some septa simple minitracellulae, forming wavy mid-septal lines are observed.

OCCURRENCE. Outcrop on east face, ca. 3 km north of the southern tip of Jebel Faiyah (bed 10), NNE of Al Madam; Coral bed (*L. hemipneustes* bed), top bed 13, outcrop forming slope and cliff on north side, about 2 km east of Jebel Rawdah, east of Al Madam.

DISTRIBUTION. Upper Cenomanian-Lower Turonian of the Czech Republic.

Genus *PHRAGMOSMILIA* Alloiteau, 1952

TYPE SPECIES. *Trochosmilium inconstans* Fromentel, 1862.

Phragmosmilium lineata (Goldfuss, 1826) Pl. 6, fig. 2

*1826 *Turbinolia lineata* Goldfuss: 108, pl. XXXVII, figs 18a–b.

1848 *Turbinolia lineata* Goldfuss; Milne Edwards & Haime, 3e sér., tome IX: 335.

1851 *Trochocyathus lineatus* (Goldfuss); Milne Edwards & Haime: 23.

1982 *Phragmosmilium lineata* (Goldfuss); Beauvais, tome I: 227–228, pl. XX, fig. 1 (older synonyms cited therein).

v1998 *Phragmosmilium lineata* (Goldfuss); Baron-Szabo: 138, pl. 2, fig. 5.

MATERIAL. AZ 60.

MEASUREMENTS. d: 15 × 12 mm; s: ca. 80.

DESCRIPTION. The corallum is simple, trochoid and slightly elliptical in outline. Costosepta are compact and arranged in 5 nearly complete cycles and 6 systems, irregularly alternating in thickness. Their lateral surfaces are covered with spiniform or thick rounded granules, and with vertical carinae. Septa of the first two cycles and some of the third cycle extend to the axial region, where their inner ends may fuse with the columella. They are usually subequal in length but differ in thickness. Septa of the fourth cycle reach about three-quarters of the length of the preceding septa. The columella is thin and lamellar, discontinuous. Endotheca consists of numerous vesicular dissepiments. The wall is septothecal, but in places epithelial lamellae are present. Septal microstructure is poorly preserved. Frequently, minitrabeculae giving off secondary trabeculae can be seen.

OCCURRENCE. *Loftusia* beds (bed 7), SW corner of Jebel Huwayyah, east of Al Ain.

DISTRIBUTION. Santonian-Campanian of Austria (Gosau Group), Campanian of northern Spain (Catalonia).

Suborder **DENDROPHYLLIINA** Vaughan & Wells, 1943

Family **DENDROPHYLLIIDAE** Gray, 1847

Genus **DENDROPHYLLIA** Blainville, 1830

TYPE SPECIES. *Madrepora ramea* Linnaeus, 1758.

Dendrophyllia nodosa Reuss, 1864 Pl. 7, figs 2–4

*1864 *Dendrophyllia nodosa* Reuss: 26, pl. VII, figs 4–7.

1889 *Dendrophyllia nodosa* Reuss; Reis: 106.

1925 *Dendrophyllia nodosa* Reuss; Felix, pars 28: 163.

MATERIAL. AZ 562.

MEASUREMENTS. dl (max): 4–6.5 mm; dl (min): 2.5–5 mm; s: 32–46; size of the colony: 20 cm in diameter.

DESCRIPTION. Massive and fasciculate colony with corallites that are embedded in a vesicular, granulated coenosteum. Gemmation is due to extracalicular budding. Corallites are irregularly disposed over the colony, circular or elliptical in outline, and are monocentric or arranged in di- to tricentric groups. They are covered by concentric laminae, which vary in thickness. Costae are numerous and thin. Septa are thin, compact or subcompact, and arranged in 3 complete cycles with the beginning of a fourth cycle, irregularly following the Pourtalès plan. Up to 20 septa extend to the centre of the calice. Trabecular prolongations of their inner ends fill the axial region, sometimes fusing with the spongy columella. Lateral surfaces of septa have delicate spiniform and rounded granules. The wall is septoparathecal. Endotheca is well-developed and consists of subtabulate or cellular dissepiments. Septal microstructure is formed by simple minitrabeculae, sometimes giving off secondary ones. Granulations of the coenosteum are made of medium sized monaxial (and ?polyaxial) trabeculae.

REMARKS. In having a calicular diameter of around 3–6 mm, 3 cycles of septa in 6 systems with the beginning of a fourth cycle, and mono- to tricentric corallites that are irregularly disposed over the colony, the specimen from UAE/Oman very closely corresponds to the original description and illustration of *Dendrophyllia nodosa* Reuss.

OCCURRENCE. East face of northernmost hill forming Jebel Buhays (loose, derived from lowest 3–4 m of section, beds 4–11), 4 km north of Al Madam.

DISTRIBUTION. Oliogocene of Austria.

Suborder **RHIPIDOGYRINA** Roniewicz, 1976

Family **RHIPIDOGYRIDAE** Koby, 1905

Genus **BARYSMILIA** Milne Edwards & Haime, 1848

TYPE SPECIES. *Dendrophyllia brevicaulis* Michelin, 1841.

Barysmilia irregularis (Reuss, 1854) Pl. 7, fig. 1

v*1854 *Placocoenia irregularis* Reuss: 100, pl. IX, fig. 9.

1857 *Favia ? irregularis* (Reuss); Milne Edwards & Haime, vol. II: 437.

1861 *Favia ? irregularis* (Reuss); Fromentel: 173.

1899 *Favia ammergensis* Söhle: 45, pl. IX, figs 5, 5a.

1899 *Placocoenia irregularis* Reuss; Söhle: 51, pl. IX, figs 4, 4a, 4b.

v1903a *Placocoenia irregularis* Reuss; Felix: 300, pl. XX, fig. 14, pl. XXV, fig. 4, text-fig. 51.

1914 *Placocoenia irregularis* Reuss; Felix, pars 7: 155.

1930 *Placocoenia irregularis* Reuss; Oppenheim: 408, pl. XXXIV, fig. 3.

1930 *Stenosmilium proletaria* Oppenheim: 437, pl. XLIII, fig. 3.

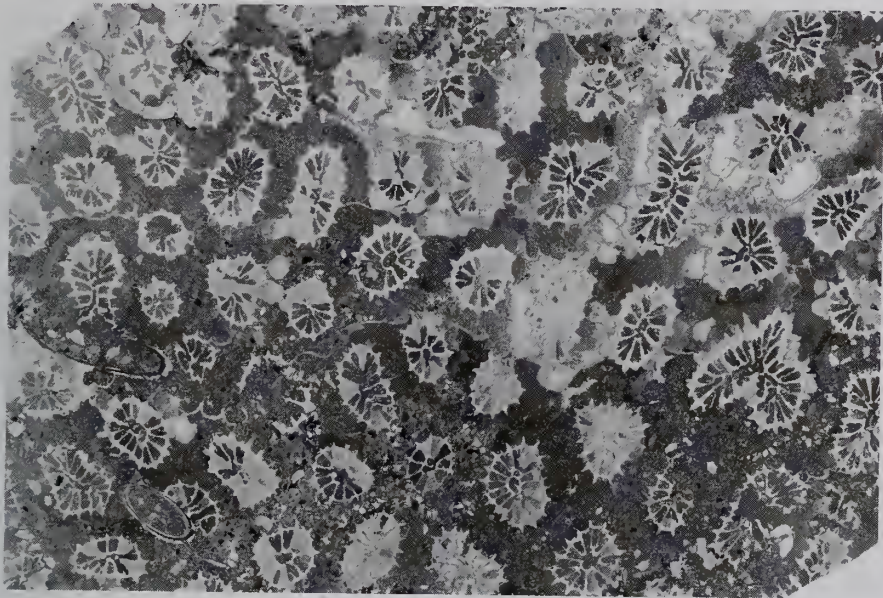
PLATE 7

Micrographs of plocoid (1) and plocoid-subfasciculate (2–4) coral colonies in transverse and longitudinal thin-sections.

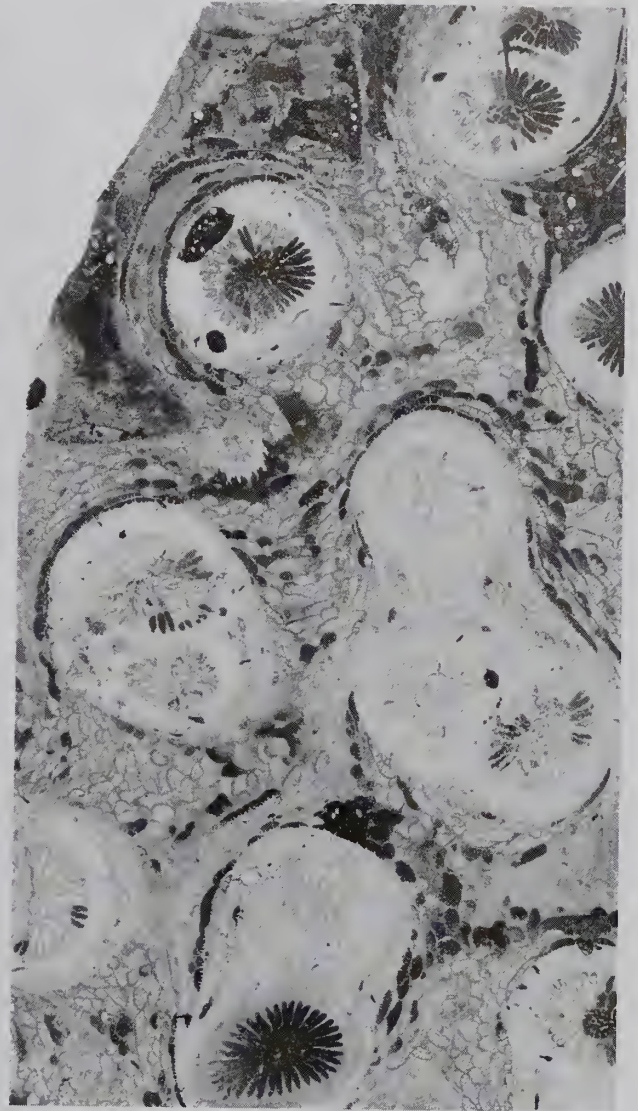
Fig. 1 *Barysmilia irregularis* (Reuss, 1854); AZ 455.

Figs 2–4 *Dendrophyllia nodosa* Reuss, 1864; AZ 562.

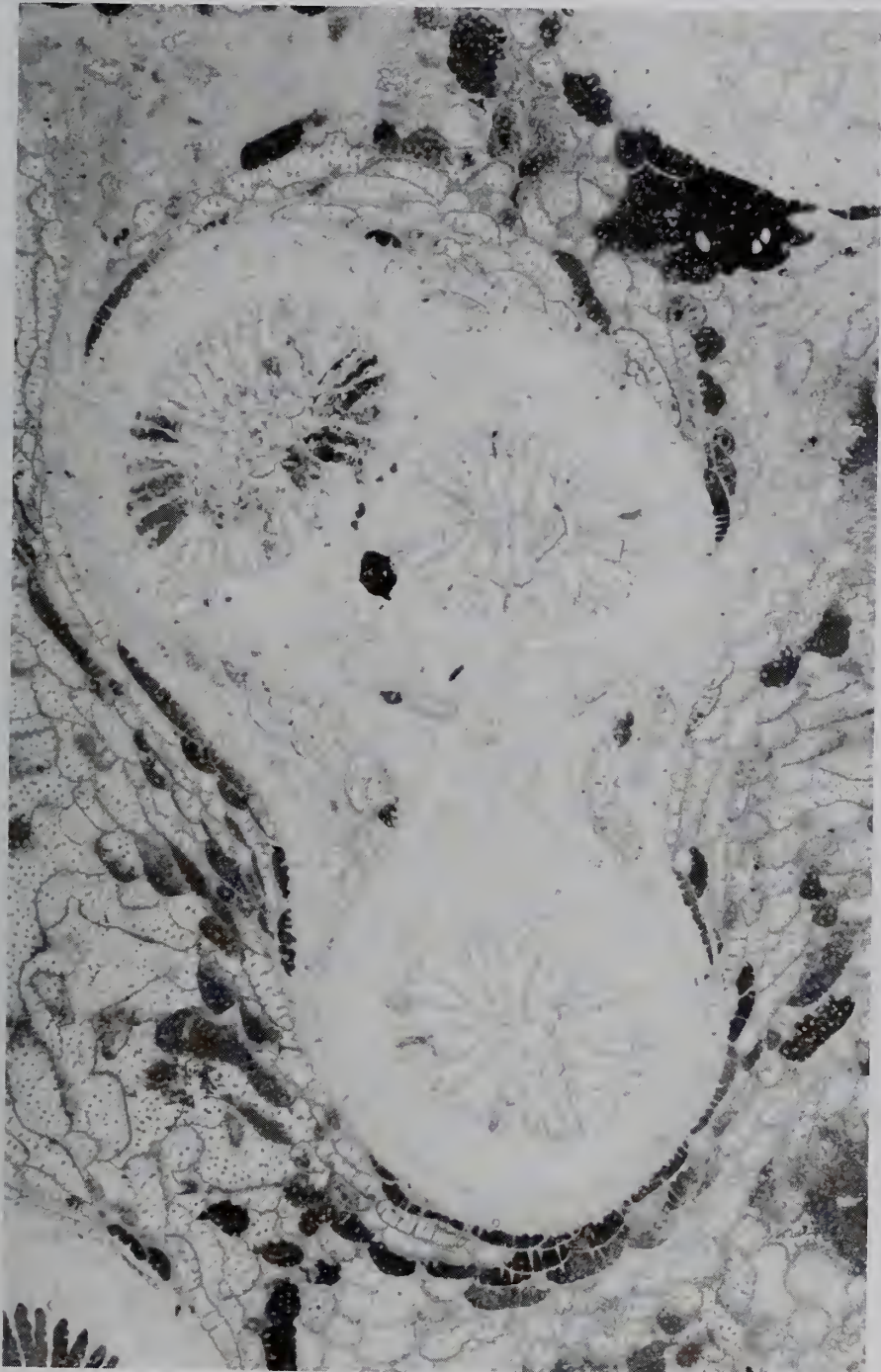
Scale bar = 3 mm.



1



2



3



4

- v1934 *Dichocoenia trechmanni* Wells: 75, pl. 2, figs 7, 8.
 1957 *Dichocoeniopsis proletaria* (Oppenheim); Alloiteau: 265, pl. 16, figs 6, 7.
 v1982 *Barysmilia irregularis* (Reuss); Beauvais, tome I: 183, pl. XIV, fig. 10, pl. XV, fig. 1.

MATERIAL. AZ 454–55; AZ 635; AZ 637.

MEASUREMENTS. d (max) (monocentric calices): 3–5 mm; d (min) (monocentric calices): 2–3.5 mm; maximum diameter in late budding stages: up to 8 mm; c–c: 4–7 mm; s (monocentric calices): 15–27, up to about 50 in tricentric corallites; size of the colony: up to 15 cm in diameter.

DESCRIPTION. The corallum forms a massive or subfasciculate (no lateral connection of the some of the corallites), plocoid or subplocoid colony. Calices are slightly elongated or elliptical in outline. Increase is due to intra- and extracalicular budding, resulting in permanent monostomatous to tristomatous conditions. Costosepta are compact and non-confluent. They are arranged in 2 or 3, sometimes 4 cycles in 5, 6, 7, or 8 systems, occurring irregularly e.g. the first cycle consists of 5 septa, followed by 6 septa of the second cycle. Development of younger septal cycles is always influenced by corallite division. Septa of the first two cycles differ in thickness but are equal in length and extend to the centre of the calice where prolongations of their inner ends may fuse. Septa of younger cycles alternate in length and thickness. Free inner ends of septa of the first and second cycle are claviform or rhopaloid. Younger septa can have thickened or cuneiform inner ends. Septal flanks are covered mainly with spiniform, but also with rounded granules. The columella is lamellar or formed by twisted segments. The wall is septothecal or septoparathecal. The endotheca consists of thin cellular dissepiments. The exotheca is made of large vesicular dissepiments. In areas of incomplete separation of the corallites several calices can be directly united by their walls. The microstructure is poorly preserved, but in places centres of calcification can be seen, corresponding to the form of neorhipidacanth trabeculae.

OCCURRENCE. East face of most northern hill forming Jebel Buhays, 4 km north of Al Madam; outcrop at southern tip of Jebel Faiyah, 6 km NNE of Al Madam.

DISTRIBUTION. Lower Coniacian of France (Corbières), Santonian-Campanian of Austria (Gosau Group), Campanian-Maastrichtian of Jamaica.

Barysmilia iberica Baron-Szabo, 1998 Pl. 8, figs 1, 3

v*1998 *Barysmilia iberica* Baron-Szabo: 144, pl. 6, figs 1–3.

MATERIAL. AZ 361; AZ 568; AZ 644.

MEASUREMENTS. d (max): 1.8–3.5 mm; d (min): (*1.3) 1.8–2.2 mm; c–c: 2–3 mm; s: 14–26 (in late budding stages the number of septa may be larger); size of the colony: 5–20 cm in diameter.

DESCRIPTION. The corallum is in the form of a massive or subfasciculate (no lateral connection of the some of the corallites),

plocoid or subplocoid colony. Increase is by intracalicular budding, resulting in permanent monostomatous to distomatous, rarely tristomatous conditions. Costosepta are compact and non-confluent. They are arranged in 2 to 3 cycles in 5, 6, 7, or 8 equal or unequal systems. Septa of the first two cycles differ in thickness but can be equal in length. They extend to the centre of the calice where they may fuse with the columella. Younger septa are distinctly shorter and thinner. In general, inner ends of S_1 and S_2 are claviform or rhopaloid. Younger septa can have thickened or cuneiform inner ends. Septal flanks are covered with spiniform and rounded granules. The columella is lamellar and thin. The wall is septothecal or septoparathecal. The endotheca consists of thin tabulate and vesicular dissepiments. The exotheca is made of tabulate and slightly arched dissepiments. The microstructure is poorly preserved, but in places neorhipidacanth trabeculae can be seen.

OCCURRENCE. Main coral bed (*Loftusia* levels, bed 7), SW corner of Jebel Huwayyah, east of Al Ain; southern tip at Jebel Faiyah, 6 km NNE of Al Madam.

DISTRIBUTION. Campanian of northern Spain (Catalonia).

Genus *ORBIGNYGYRA* Alloiteau, 1952

TYPE SPECIES. *Diploria neptuni* d'Orbigny, 1850.

Orbignygyra salisburgensis (Milne Edwards & Haime, 1849) Pl. 8, fig. 2, Pl. 9, fig. 1

1845 *Meandrina tenella* Michelin: 293, pl. 66, fig. 5.

*1849 *Meandrina?* *saltzburgiana* Milne Edwards & Haime, 3. ser., tome XI: 283.

v1854 *Meandrina saltzburgiana* Milne Edwards & Haime; Reuss: 109, pl. XV, figs 12, 13.

1877 *Dendrogyra salisburgensis* (Milne Edwards & Haime); Fromentel: 440.

v1903a *Dendrogyra salisburgensis* (Milne Edwards & Haime); Felix: 306, pl. XXII, fig. 14, text-figs 54, 55.

non 1956 *Meandrina tenella* Michelin; Bendukidze: 89, pl. II, fig. 5.

1982 *Orbignygyra salisburgensis* (Milne Edwards & Haime); Beauvais, tome I: 204, pl. XVI, figs 4, 5, pl. LXIII, fig. 4 (older synonyms cited therein).

MATERIAL. AZ 584–85.

MEASUREMENTS. d (series): 4–8 mm; d (ambulacrum): 0.5–3 mm; s/ mm: 15–18/ 10; size of the colony: 15–25 cm in diameter.

DESCRIPTION. The corallum is a massive, meandroid colony with indistinct or subdistinct corallites, which are arranged in short sinuous series. Gemmation is due to intracalicular budding. Costosepta are compact, nonconfluent, and arranged in 3 size orders. Septa of the first order extend to the central region of the series. In general, their inner ends are claviform or rhopaloid, sometimes fusing with the columella. Septa of the second size order slightly alternate in

PLATE 8

Micrographs of plocoid (1, 3), meandroid (2), cerioid (4), and thamnasterioid (5) coral colonies in transverse and longitudinal thin-sections, and upper surface view.

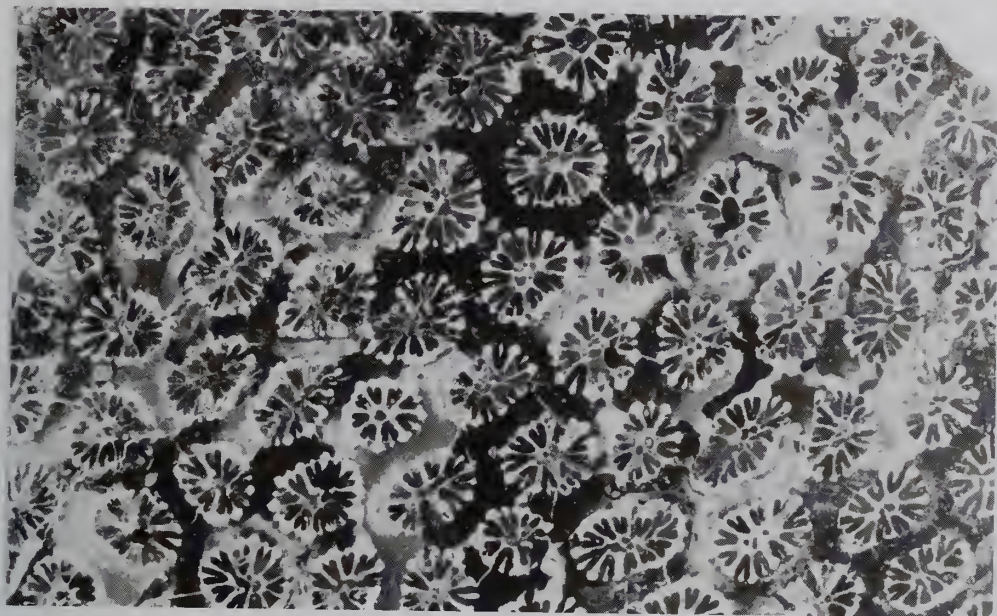
Figs 1, 3 *Barysmilia iberica* Baron-Szabo, 1998; AZ 361.

Fig. 2 *Orbignygyra salisburgensis* (Milne Edwards & Haime, 1849); AZ 584.

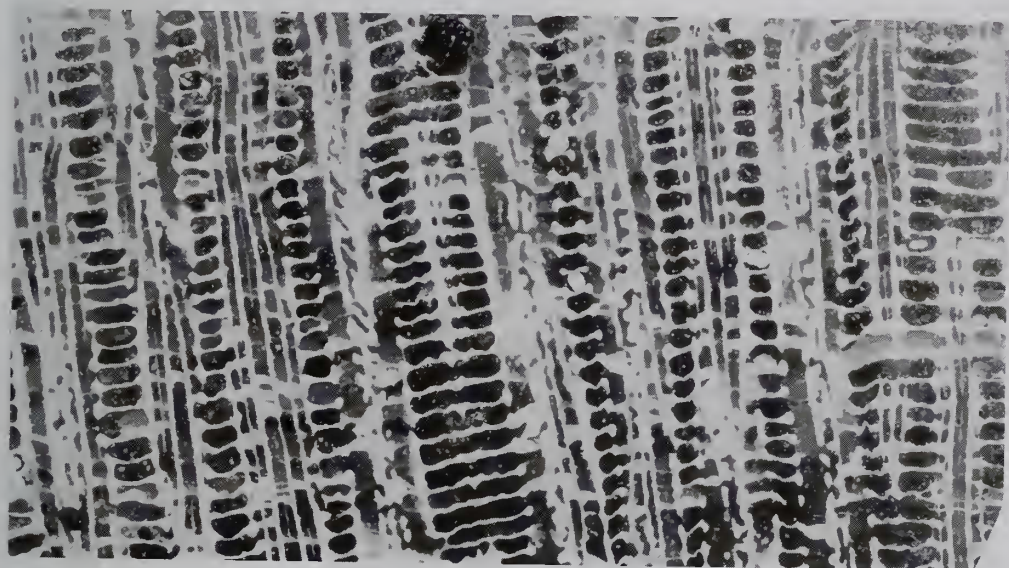
Fig. 4 *Pseudofavia grandiflora* (Reuss, 1854); AZ 406.

Fig. 5 *Astraraea multiradiata* (Reuss, 1854); AZ 409.

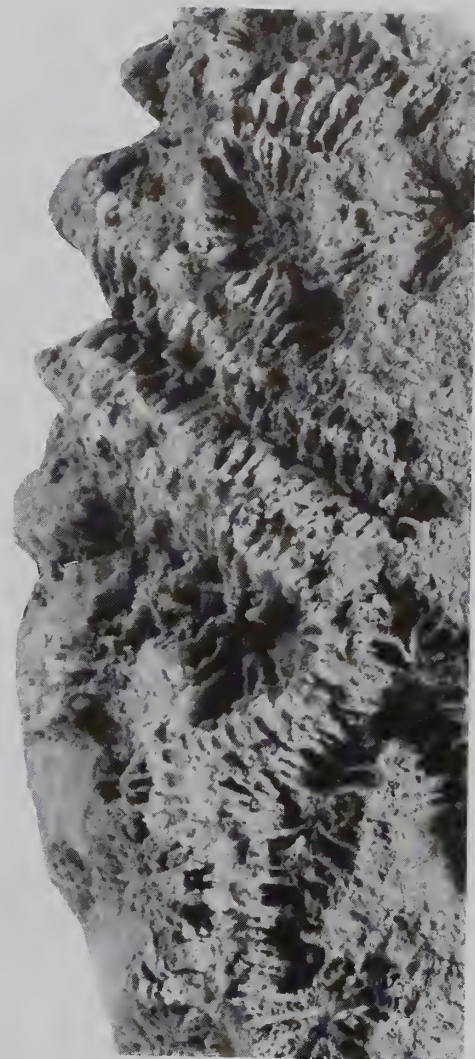
Scale bar = 3 mm.



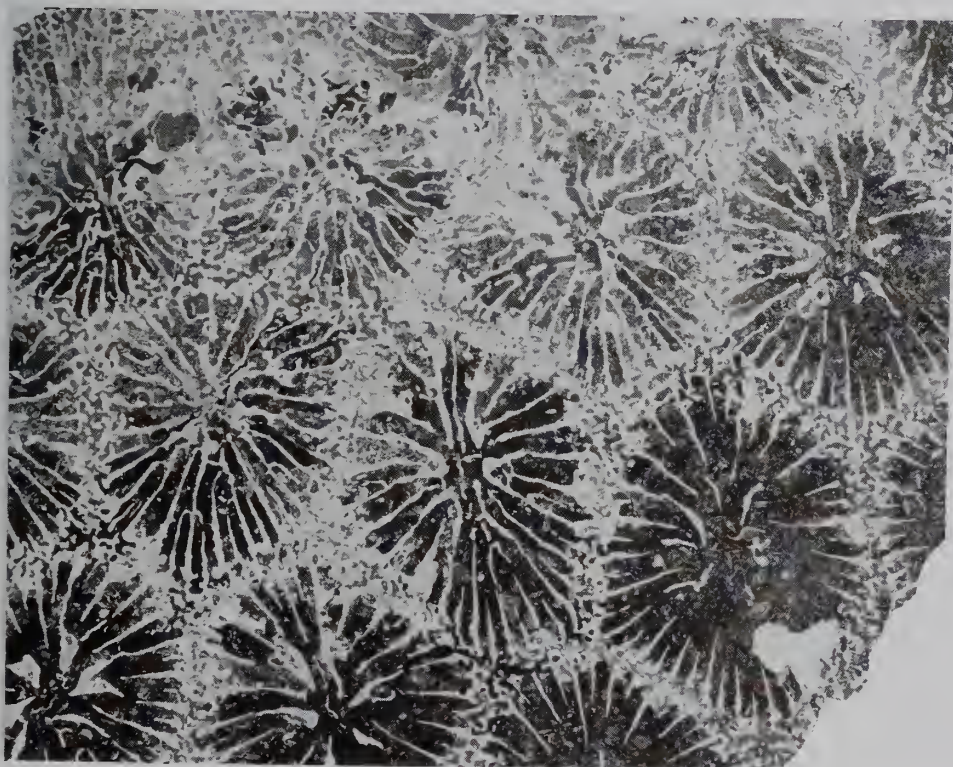
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4



5

length and thickness. Youngest septa are distinctly thinner and shorter. Lateral surfaces of septa are covered with rounded granules. The columella is lamellar, discontinuous. Wall is septothecal and parathecal. Endotheca consists of vesicular dissepiments, mainly occurring in the peripheral areas of the calicinal series.

REMARKS. The taxon *Meandrina tenella* Michelin (1845) represents a homonym of *Meandrina tenella* Goldfuss (1826). Therefore, the younger synonym by Milne Edwards & Haime (1849) has priority. In revising *Meandrina ? salzburgiana* Milne Edwards & Haime, 1849, Fromentel (1877) grouped this form with the genus *Dendrogyra* and fully Latinized the species name to *salisburgensis*. According to the rules of nomenclature creating Latinized names for taxa is strongly recommended but it does not concern the validity of non-Latinized names. Therefore, the changes by Fromentel were not necessary. However, because the Latinized modification of the form by Milne Edwards & Haime has been constantly in use for over a century the author follows the rules of nomenclature in that a name is kept because it has been well known (Article 33.2.3.1); changing it back may cause confusion.

OCCURRENCE. Outcrop forming slope on south side of valley (bed 4), ca. 3 km east of Jebel Rawdah, east of Al Madam.

DISTRIBUTION. ?Senonian of Hungary, Santonian of Austria (Gosau Group), Upper Santonian of southern France (Corbières).

Suborder FUNGIINA Verrill, 1865

Family HAPLARAEEIDAE Vaughan & Wells, 1943

Genus ASTRARAEA Felix, 1900

TYPE SPECIES. *Thamnastraea multiradiata* Reuss, 1854.

Astraraea multiradiata (Reuss, 1854) Pl. 8, fig. 5

- v*1854 *Thamnastraea multiradiata* Reuss: 118, pl. VII, fig. 1.
 1858–61 *Synastraea multiradiata* (Reuss); Fromentel: 219.
 1900 *Astraraea multiradiata* (Reuss); Felix: 38.
 v1903a *Astraraea multiradiata* (Reuss); Felix: 186, text-figs 10, 11.
 1914 *Astraraea multiradiata* (Reuss); Felix, pars 7: 205.
 1952a *Astraraea multiradiata* (Reuss); Alloiteau: 608, pl. II, fig. 9.
 1982 *Astraraea multiradiata* (Reuss); Beauvais, tome II: 30, pl. XXIV, fig. 3, pl. XXV, fig. 1 (older synonyms cited therein).

MATERIAL. AZ 408–09.

MEASUREMENTS. c–c: 10–22 mm; s/ mm: 4–5/ 2; size of the colony: 3–7 cm in diameter.

DESCRIPTION. Massive, thamnasterioid colony with calices, which are regularly disposed. There are no corallite walls and septa are confluent between calices. Septa are subequal in thickness, irregularly perforated, and united by numerous synapticalae. About 30 septa extend to the columella. Septal flanks are covered with rounded

granules and pennulae. The columella is spongy-papillose, well-developed. Endotheca consists of vesicular or subtabulate dissepiments. Microstructure is made of monaxial and polyaxial thick trabeculae.

OCCURRENCE. Main coral bed (*Loftusia* levels, beds 3–8), SW corner of Jebel Huwayyah, east of Al Ain.

DISTRIBUTION. Lower Coniacian of southern France (Corbières), Santonian of Austria (Gosau Group).

Genus PSEUDOFAVIA Oppenheim, 1930

TYPE SPECIES. *Parastraea grandiflora* Reuss, 1854.

Pseudofavia grandiflora (Reuss, 1854) Pl. 8, fig. 4

- v*1854 *Parastraea grandiflora* Reuss: 120, pl. XVI, fig. 10.
 v1903a *Parastraea grandiflora* Reuss; Felix: 181, fig. 7.
 1930 *Pseudofavia grandiflora* (Reuss); Oppenheim: 65, pl. XL, fig. 5.
 1943 *Pseudofavia grandiflora* (Reuss); Vaughan & Wells: 133, pl. 16, fig. 10.
 1976 *Pseudofavia grandiflora* (Reuss); Turnšek, in Turnšek & Buser: 60, 81, pl. 18, figs 1–3.
 v1982 *Pseudofavia grandiflora* (Reuss); Beauvais, tome II: 16, pl. XXIII, fig. 3 (older synonyms cited therein).
 1997 *Pseudofavia grandiflora* (Reuss); Turnšek: 174, figs 174 A–E.

MATERIAL. AZ 406.

MEASUREMENTS. d (max): 11–15 mm; d (min): 9–12 mm; c–c: 9–11; s: (*44) 48–60; size of the colony: about 9 cm in diameter.

DESCRIPTION. The corallum is in the form of a massive, cerioid colony. Corallites are polygonal in outline and separated by a vermiculate coenosteum, which is up to 2 mm in thickness. Septa are compact or subcompact, and arranged in 4 complete with the beginning of a fifth cycle in 6 systems. They regularly alternate in length, but can be nearly equal in thickness. Lateral surfaces of septa are covered by mostly delicate granules. Occasionally, thick rounded granules occur. Septa of the first two cycles reach the centre of the calice. Their inner ends may meet and fuse with the columella, or dissociate into paliform structures. Remaining septa alternate in length. The columella is spongy-papillose or consists of elongated segments. The occurrence of synapticalae is mainly restricted to both the peripheral areas of corallite and the peritheca. Wall is an incomplete paratheca or synapticalotheca. Endotheca is formed by subtabulate or vesicular dissepiments.

REMARKS. The description of the type of *Pseudofavia grandiflora* (Reuss) by Beauvais (1982, tome II: 16–17) disagrees with the type material in that it does not reflect the whole spectrum of variation in the specimen. Beauvais gives 21.5–35.5 mm for the calicular diameter, which corresponds to the largest corallites only (unpublished data, Baron-Szabo, 1995). In the type specimen corallites having a maximum diameter of (11) 15–22 mm are most common.

PLATE 9

Micrographs of meandroid (1), cerioid (2, 3), and branching phaceloid (4) coral colonies in transverse thin-sections.

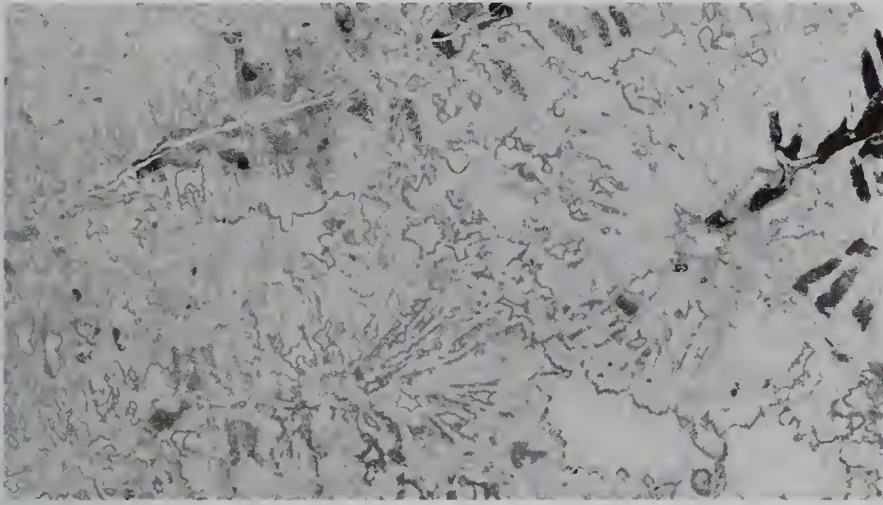
Fig. 1 *Orbigygyra salisburgensis* (Milne Edwards & Haime, 1849); AZ 584.

Fig. 2 *Goniopora elegans* (Leymerie, 1846); AZ 417.

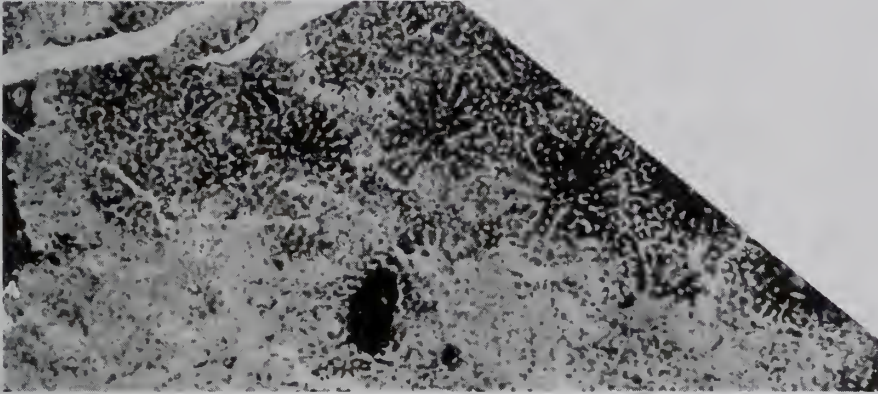
Fig. 3 *Goniopora imperatoris* Vaughan, 1919; AZ 415.

Fig. 4 *Calamophylliopsis simonyi* (Reuss, 1854); AZ 580.

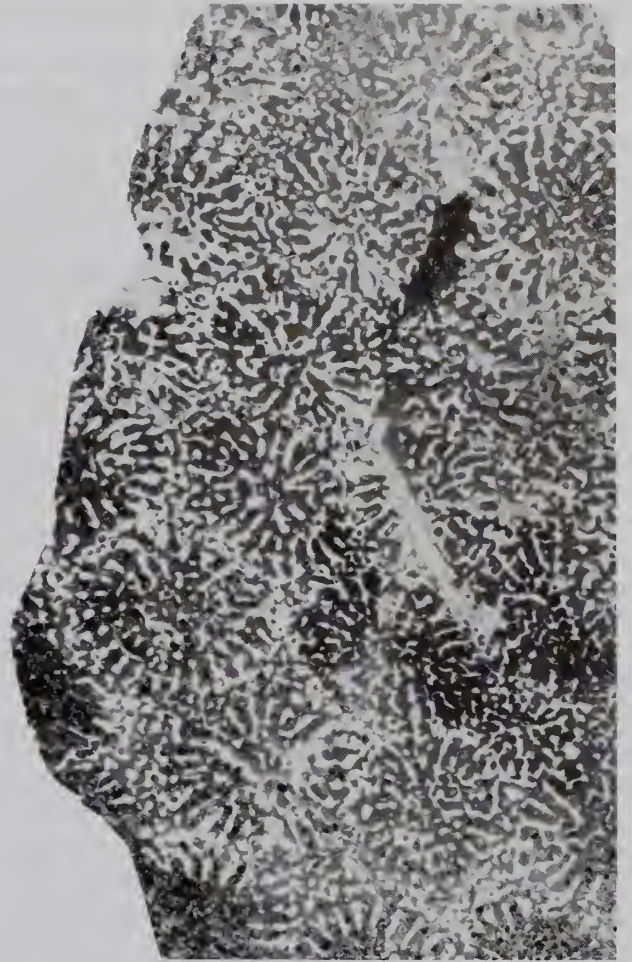
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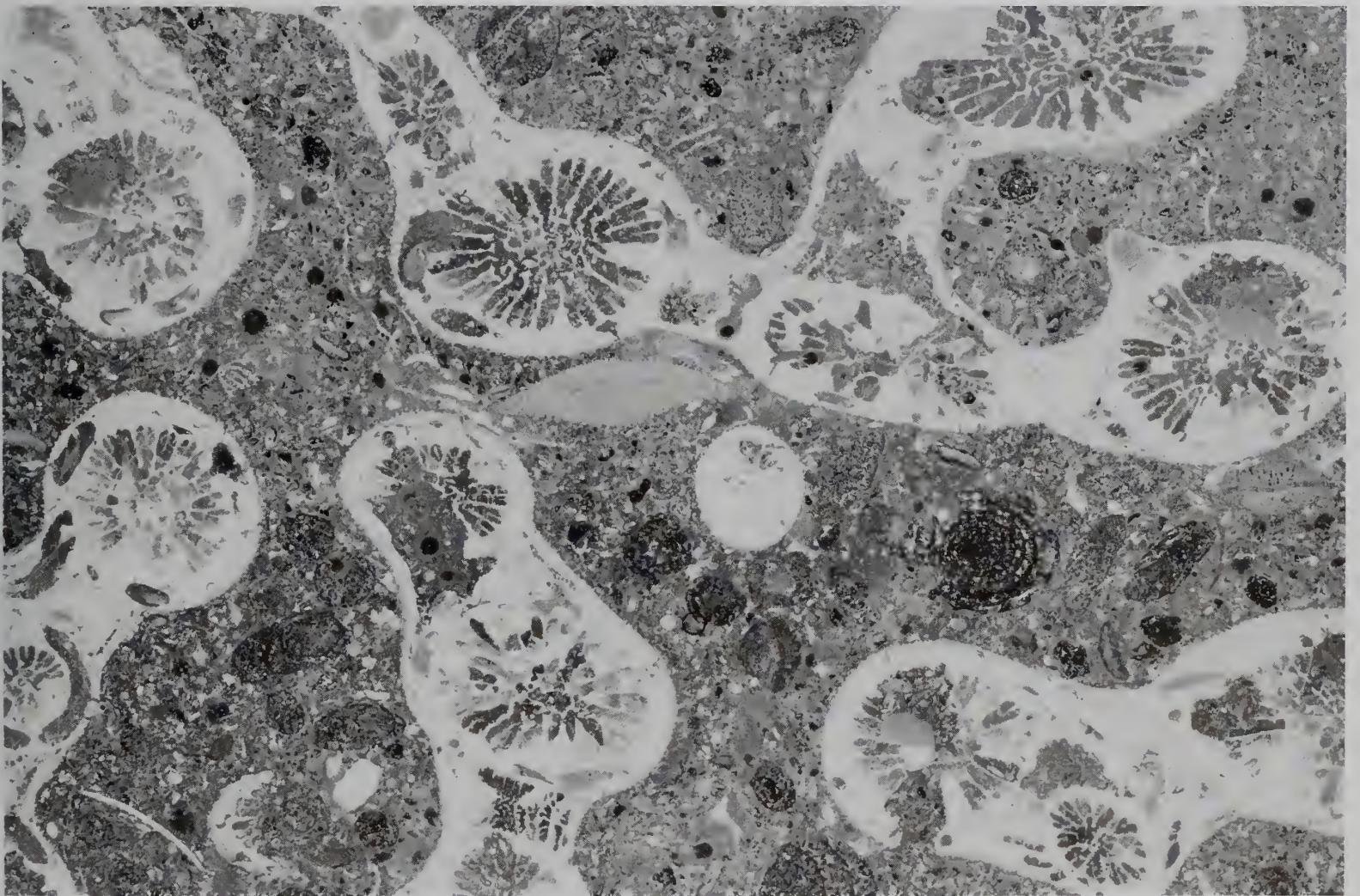
1



3



2



4

OCCURRENCE. SW corner of Jebel Huwayyah, east of Al Ain.

DISTRIBUTION. Senonian breccia (redeposited) of Slovenia, ?Senonian of Georgia (in Caucasia), Santonian of Austria (Gosau).

Family **PORITIDAE** Gray, 1842
Genus **GONIOPORA** Blainville, 1830

TYPE SPECIES. *Goniopora pendunculata* Quoy & Gaimard in Blainville, 1830.

Goniopora elegans (Leymerie, 1846) Pl. 9, fig. 2

- *1846 *Porites elegans* Leymerie: 358, pl. 13.
- 1868 *Dictyaraea elegans* (Leymerie); Reuss: 163, pl. 15, figs 6, 7.
- 1882 *Litharaea* sp.; Pratz: 223.
- 1884 *Goniaraea elegans* (Leymerie); Felix: 424, pl. 3, figs 1, 2.
- 1912 *Goniaraea elegans* (Leymerie); Oppenheim: 98, pl. 12 (3), figs 2, 3, text-fig. 2.
- 1915 *Goniaraea elegans* (Leymerie); Dainelli: 216.
- 1942 *Goniaraea elegans* (Leymerie); Solè Sabaris: 398, pl. 8, fig. 52.
- 1987 *Goniopora elegans* (Leymerie); Kuzmicheva: 158, pl. XXVIII, fig. 7.
- 1988 *Goniopora elegans* (Leymerie); Drobne *et al.*: 188, pl. 34, figs 1–3.
- 1996 *Goniopora elegans* (Leymerie); Schuster: 73, pl. 15, fig. 4.

MATERIAL. AZ 412; AZ 416–17; AZ 419; AZ 960–61.

MEASUREMENTS. d: 2.5–4.5 mm; c–c: 3.5–6 mm; s: 20–24; size of the colony: about 8 cm in diameter.

DESCRIPTION. The corallum is massive with calices, that are rounded or irregularly polygonal in outline. Corallites are separated by a reticulated coenosteum. Septa are subcompact or porous, thin to moderate, nearly equal in thickness, and arranged in a bilateral system. Their lateral surfaces have delicate spiniform or rounded granules. About 10 septa reach the centre of the calice, where their inner ends may dissociate to form paliform structures or produce trabecular prolongations that join, or fuse with, the columella. Another order consisting of up to 10 septa reaches about half the length of S1, sometimes fusing with them. The columella is irregular spongy-papillose or formed by twisted segments. The wall is parathecal or synapticulothecal, incomplete. Endothecal dissepiments are rare. Thin synapticulae occur throughout the whole colony.

REMARKS. The specimens from the UAE/Oman very closely agree with the descriptions and illustrations of the forms listed in synonymy.

OCCURRENCE. Qahlah Formation, SW of Jebel Huwayyah, east of Al Ain; *Loftusia* bed (beds 3–8), SW corner of Jebel Huwayyah, east of Al Ain.

DISTRIBUTION. Lower Paleocene of Croatia and the Ukraine, Eocene of Egypt, France, Bosnia, and Spain, Eocene-Lower Oligocene of Italy.

Goniopora imperatoris Vaughan, 1919 Pl. 9, fig. 3

- *v1919 *Goniopora imperatoris* Vaughan: 493, pl. 142, figs. 3, 3a.
- v1986 *Goniopora imperatoris* Vaughan; Foster: 85, pl. 35, figs. 3–7, pl. 36, figs. 1–7, pl. 37, figs. 1–4, text-figs. 2, 3, 6, 8, 11, 13, 14 (older synonyms cited therein).

MATERIAL. AZ 415; AZ 418; AZ 460.

MEASUREMENTS. d: (*1.5) 1.8–2.8 mm; c–c: (*2) 2.5–4 mm; s: 16–26; size of the colony: 8–10 cm in diameter.

DESCRIPTION. The corallum is massive, with calices that are rounded or polygonal in outline. Corallites are separated by a reticulated coenosteum. Septa are subcompact or porous, thin, nearly equal in thickness, and have delicate granulations laterally. Septal arrangement is bilateral. An order, consisting of about 8 septa, extends to the centre of the corallite, where the septa might dissociate to form paliform structures or trabecular prolongations, which join with the columella. A second order of about 8 septa reaches three-quarters the length S1. Youngest septa can be nearly equal with S2. Paliform structures irregularly occur axial to septa of every order. Columella is spongy or made of thin, twisted segments. Numerous synapticulae are scattered over the colony. The wall is synapticulothecal, incomplete. Endotheca consists of a few, thin dissepiments

REMARKS. The specimens from the UAE/ Oman closely correspond to the Tertiary forms of the Caribbean and Maastrichtian material from Jamaica (Baron-Szabo, in prep.).

OCCURRENCE. *Loftusia* bed (beds 3–8), SW corner of Jebel Huwayyah, east of Al Ain; loose, derived from lowest 3–4 m of section (beds 4–11), east face of most northern hill forming Jebel Buhays, 4 km north of Al Madam.

DISTRIBUTION. ?Upper Oligocene (Antigua Formation) of Antigua and ?Mexico (La Quinta Formation), Lower Miocene of Anguilla (Anguilla Formation) and ?Georgia (Chattahoochee Formation), Middle Miocene of Panama (La Boca Formation) and Puerto Rico (Ponce Formation), Lower Pliocene of the Dominican Republic.

Family **ACTINACIDIDAE** Vaughan & Wells, 1943
Genus **ACTINACIS** d'Orbigny, 1849

TYPE SPECIES. *Actinacis martiniana* d'Orbigny, 1849.

Actinacis parvistella Oppenheim, 1930 Pl. 11, figs 1, 3

- 1881 *Actinacis haueri* Reuss: Quenstedt, VI: 900, pl. 178, fig. 28.
- *1930 *Actinacis parvistella* Oppenheim: 9, pl. I, figs 3, 3a.
- 1930 *Actinacis multilamellata* Oppenheim: 13, pl. XV, fig. 2.
- v1933 *Actinacis valverdensis* Wells: 120, pl. 11, figs 1, 2.
- 1982 *Actinacis parvistella* Oppenheim; Beauvais, tome II: 273, pl. XLIX, figs. 1, 2, pl. LXIX, fig. 3.
- 1982 *Actinacis multilamellata* Oppenheim; Beauvais, tome II: 274, pl. XLIX, figs 3, 4, pl. LXIX, fig. 2.
- v1998 *Actinacis parvistella* Oppenheim; Baron-Szabo: 147, pl. 11, fig. 1.

MATERIAL. AZ 367; AZ 514; AZ 569; AZ 576; AZ 641; AZ 666; AZ 2528.

MEASUREMENTS. d: 0.8–1.2 (*1.5) mm; c–c: 1.5–3 mm; s: (*20–) 24; size of the colony: encrusting-lamellar: 35 × 12 mm; massive: 12–20 cm in diameter.

DESCRIPTION. The corallum forms an encrusting-lamellar or massive, plocoid colony. Circular or slightly oval calices have an average diameter of nearly 1 mm, and are separated by a vermiculate coenosteum. Costosepta, of which about 8 extend to the columella, are compact or subcompact, straight, nearly equal in thickness, but irregularly alternating in length. Anastomosis of septa is an irregular, but common feature. Paliform structures irregularly occur. All septa are thickened near the wall. Their lateral surfaces have spiniform

granulations. The columella is lamellar or formed by a few elongated segments. Numerous synapticulae are scattered throughout the colony. The wall is an incomplete (para-) synapticulotheca, made of one synapticular ring. Rare dissepiments are developed near the wall.

REMARKS. On the basis of the studies carried out by Beauvais (1982) the forms *Actinacis parvistella* Oppenheim and *Actinacis multilamellata* Oppenheim are considered to be synonymous. However, *Actinacis valverdensis* Wells closely agrees with both of these species.

OCCURRENCE. Main coral bed, *Loftusia* Levels (beds 7, 9), SW corner of Jebel Huwayyah, east of Al Ain; NE corner of Jebel Buhays, 4 km north of Al Madam; east face forming most northern hill of Jebel Buhays, 4 km north of Al Madam; outcrop at southern tip of Jebel Faiyah, 6 km NNE of Al Madam.

DISTRIBUTION. Middle Albian of Texas, Lower Coniacian of southern France, Upper Coniacian-Santonian of Austria (Gosau Group), Campanian of northern Spain (Catalonia).

Actinacis remesi Felix, 1903 Pl. 10, figs 3, 6

- *1903c *Actinacis remesi* Felix: 567, text-figs 1, 2.
 1911 *Actinacis remesi* Felix; Trauth: 155, pl. IV, fig. 1, text-fig. 4.
 1914 *Actinacis remesi* Felix; Felix, pars 7: 240.
 1925 *Actinacis remesi* Felix; Vettors: 9, pl. I, figs 5, 6.
 non 1925 *Actinacis remesi* Felix; Kühn: 131.
 1930 *Actinacis remesi* Felix; Oppenheim: 10, pl. XV, figs 3, 3a.
 ?1966 *Actinacis remesi* Felix; Morycowa & Lefeld: 538, pl. 33, figs 1, 2.
 1976 *Actinacis remesi* Felix; Turnšek, in Turnšek & Buser: 63, 83, pl. 20, figs 5, 6.
 1982 *Actinacis remesi* Felix; Beauvais, tome II: table 12.
 1989 *Actinacis remesi* Felix; Eliasova: 96, pl. 50, figs 2, 3; pl. 56, fig. 3; pl. 59, figs 1, 2; pl. 60, fig. 1.

MATERIAL. AZ 570.

MEASUREMENTS. d: (*1.5) 1.8–2.5 mm; c–c: 2.5–4 mm; s: (*15) 17–22.

DESCRIPTION. Massive-lamellar and plocoid colony with corallites that are circular or elongated in outline. Calices are embedded in a very porous coenosteum. Costosepta are subcompact or porous, equal in thickness, with finely granulated lateral surfaces. In some calices a septal arrangement in 6 systems is perceptible. Paliform structures irregularly occur. The columella is made of a few papillae or twisted segments, sometimes uniting with inner ends of septa. Wall is an incomplete synapticulotheca. Endothecal dissepiments are thin, vesicular, and few in number. Synapticulae are disposed throughout the whole colony.

OCCURRENCE. NE side of Jebel Thanais, 4 km north of Al Madam.

DISTRIBUTION. ?Urgonian of Poland, Upper Cenomanian-Lower Santonian of the Czech Republic, Turonian-Senonian of Libya, Santonian-Campanian (Gosau Group) and Maastrichtian (northern alpine flysch) of Austria, redeposited in Senonian breccia of Slovenia.

Family ANDEMANTASTRAEIDAE Alloiteau, 1952

Genus BRACHYCOENIA Beauvais, 1982

TYPE SPECIES. *Adelastrea leptophylla* Reuss, 1854.

Brachycoenia leptophylla (Reuss, 1854) Pl. 11, fig. 2

- *1854 *Adelastrea leptophylla*: Reuss: 115, pl. XII, figs 3, 4.
 1857 *Confusastraea leptophylla* (Reuss); Milne Edwards & Haime, tome II: 484.
 ?1956 *Confusastraea leptophylla* (Reuss); Bendukidze: 85, pl. IX, figs 2, 2a.
 1982 *Brachycoenia leptophylla* (Reuss); Beauvais, tome II: 48, pl. XXVI, fig. 7, pl. XXVII, fig. 1 (older synonyms cited therein).
 v1999 *Brachycoenia leptophylla* (Reuss); Baron-Szabo: x, pl. 1, fig. 6, pl. 4, fig. 3.

MATERIAL. AZ 476.

MEASUREMENTS. c–c: 5–10 mm; s: 36–60, in late budding stages the number of septa may be larger; s/mm: 6–7/2; size of the colony: 7 cm in diameter.

DESCRIPTION. The massive and thamnasterioid colony has slightly protuberant calices, which appear to be subplocoid. Increase is due to intracalicular gemmation. Costosepta are subcompact or porous, confluent or subconfluent, nearly equal in thickness, and have pennulae and spiniform or coarse, rounded granules laterally. Their inner ends have a tendency to fuse. About 20 septa reach the centre of the calice. The columella is spongy-papillose, well-developed. Paliform structures can be frequently observed. Synapticulae are irregularly disposed. There is no wall between the corallites. Endotheca is formed by numerous vesicular or subtabulate dissepiments. Septal microstructure is made of thick monaxial and polyaxial trabeculae.

OCCURRENCE. SE corner of Jebel Huwayyah (beds 10/11), east of Al Ain.

DISTRIBUTION. ? Senonian of Georgia (in Caucasia), Upper Santonian-Campanian of Austria (Gosau Group).

Genus MESOMORPHA Pratz, 1882

TYPE SPECIES. *Porites mammillata* Reuss, 1854.

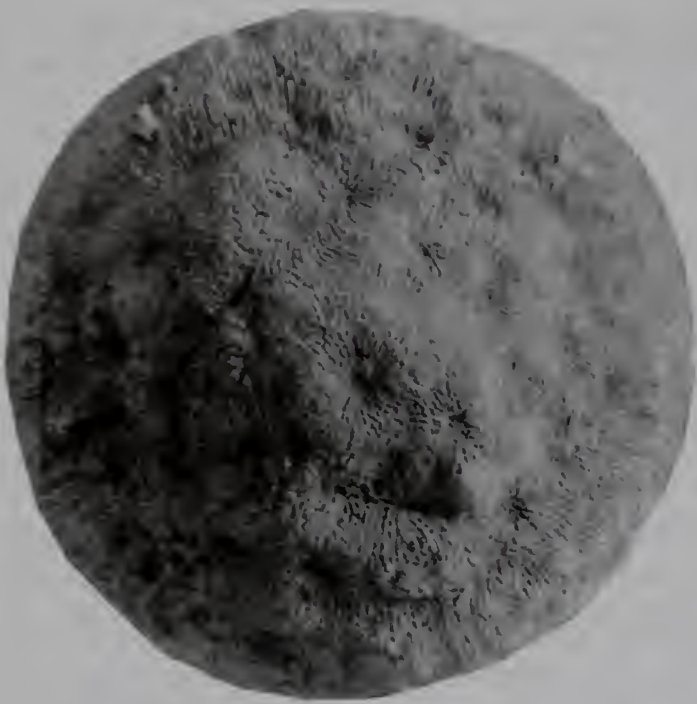
Mesomorpha mammillata (Reuss, 1854) Pl. 10, fig. 2, 8

- v*1854 *Porites mammillata* Reuss: 129, pl. X, figs 9, 10.
 1860 *Coscinaraea mammillata* (Reuss); Milne Edwards, tome III: 204.
 1882 *Mesomorpha mammillata* (Reuss); Pratz: 114.
 v1903a *Mesomorpha mammillata* (Reuss); Felix: 225.
 1957 *Ahrdorffia mammillata* (Reuss); Alloiteau: pl. 4, fig. 10.
 v1982 *Mesomorpha mammillata* (Reuss); Beauvais, tome II: 61, pl. XXVI, fig. 5 (older synonyms are cited therein).

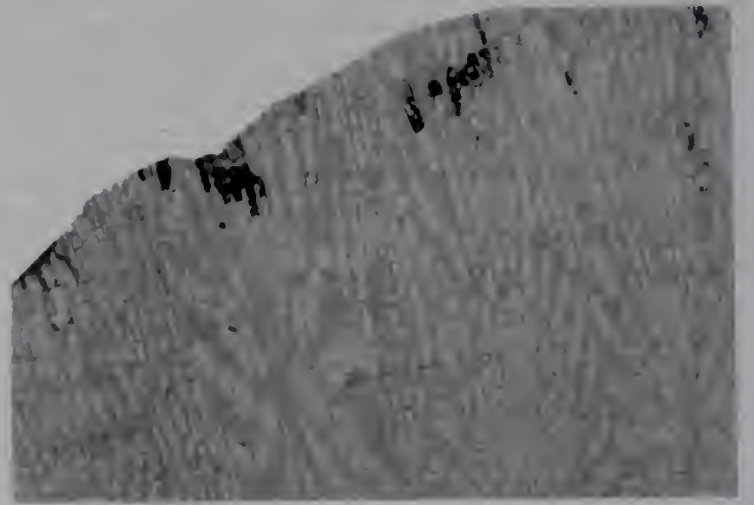
MATERIAL. AZ 904.

MEASUREMENTS. d: 2–2.5 mm, in later budding stages the corallite diameter can reach up to 3.5 mm; c–c: 2–4 mm; s: 18–24, in late budding stages the number of septa may reach 30; s/mm: 8–10/2; size of the colony: about 7 cm in diameter.

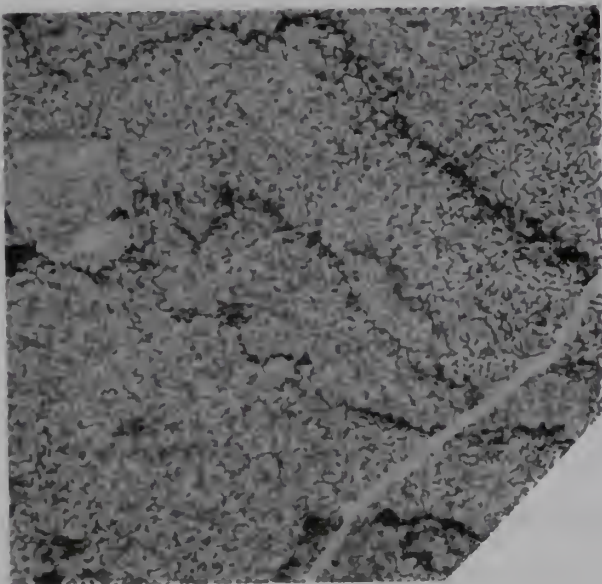
DESCRIPTION. Massive and thamnasterioid colony with corallites that appear to be polygonal in outline. Gemmation is due to intracalicular budding. Septa are compact, confluent, sub- or non-confluent, nearly equal in thickness, and finely granulated laterally. About 10 septa reach the centre of the calice, where they meet and fuse with the columella. Anastomosis is a common feature. The columella is styliform. Synapticulae are very abundant and occur



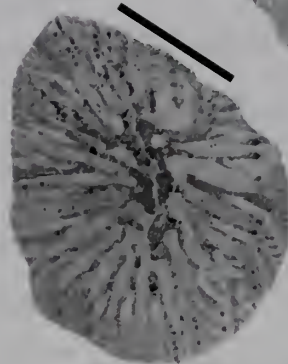
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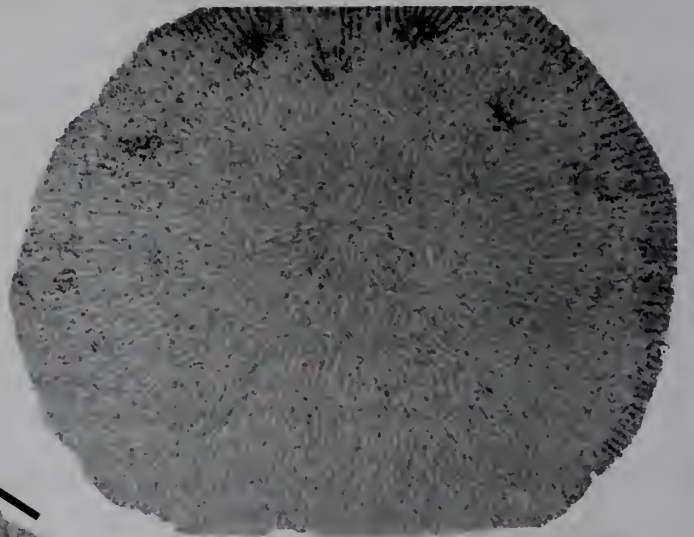
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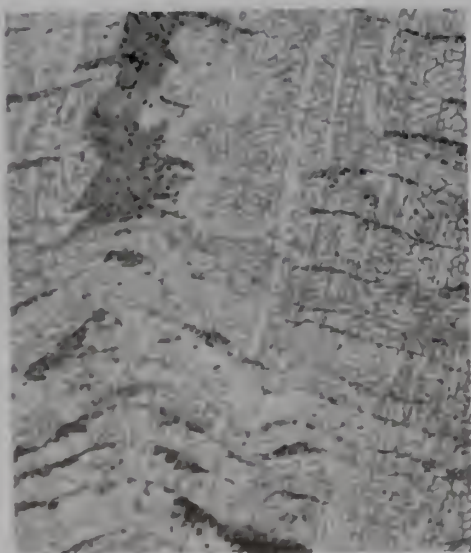
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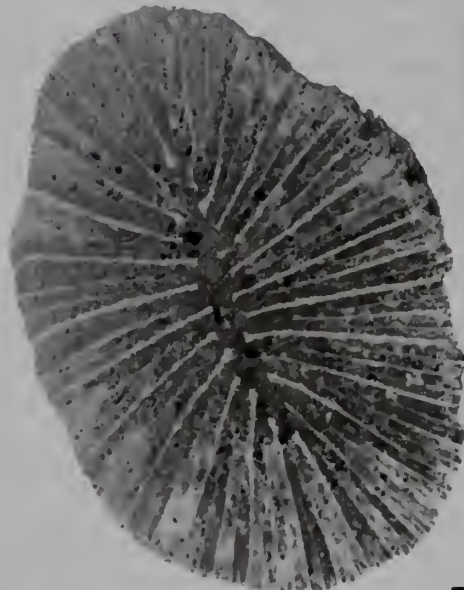
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8



6



7

throughout the whole colony. Endotheca consists of numerous thin, slightly arched or cellular dissepiments.

REMARKS. In the present specimen the majority of corallites is in condition of gemmation, resulting in a larger corallite diameter and a larger number of septa. However, in calices which are not influenced by budding the calicinal diameter is 2 mm and the number of septa is around 20, thus closely agreeing with the type material of *Mesomorpha mammillata* (Reuss). Another similar species represents the form *M. forojuliensis* d' Archiardi, 1875, from the Eocene of Italy, with a corallite diameter of around 3 mm, but the number of septa can reach up to 60 in late budding stages.

OCCURRENCE. SE corner of Jebel Huwayyah, east of Al Ain.

DISTRIBUTION. Lower Coniacian (Corbières, Aude) and Upper Santonian (Aude) of France, Santonian of Austria (Gosau Group).

Suborder **MICROSOLENINA** Morycowa & Roniewicz, 1995
Family **LATOMEANDRIDAE** Alloiteau, 1952
Genus **FUNGIASTRAEA** Alloiteau, 1952

TYPE SPECIES. *Astrea laganum* Michelin, 1841.

Fungiastraea crespoid (Felix, 1891) Pl. 11, fig. 4

- *1891 *Thamnastrea crespoid*: Felix: 146, pl. 22, fig. 5.
- 1963 *Thamnastreaa crespoid* Felix; Reyer Navarros: 4, pl. 1, figs 1, 4.
- 1994 *Fungiastraea crespoid* (Felix); Löser: 66, pl. 9, fig. 4, pl. 11, figs 8, 9.
- v1996 *Fungiastraea crespoid* (Felix); Baron-Szabo, in Baron-Szabo & Steuber: 27, pl. 16, figs 2, 3.
- v1997 *Fungiastraea crespoid* (Felix); Sanders & Baron-Szabo: 74, pl. 21, fig. 8 (non fig. 7).
- v1997 *Fungiastraea crespoid* (Felix); Baron-Szabo: 88, pl. 16, fig. 3.
- v1999 *Fungiastraea crespoid* (Felix); Baron-Szabo & González-Léon: 490, figs 5(a), 6(i).

MATERIAL. AZ 642.

MEASUREMENTS. c-c: 4–8 mm; s/mm: 4–6/2; size of the colony: about 5 cm in diameter.

DESCRIPTION. The corallum is massive-lamellar and thamnasterioid. Septa are long, wavy, confluent, nearly equal in thickness, irregularly perforated, and have rounded or spiniform granules and pennulae laterally. The columella is spongy-papillose. A small number of synapticalae are irregularly distributed. The endotheca is made of thin tabulate and slightly arched dissepiments.

OCCURRENCE. *Loftusia* beds (beds 3–8), SW corner of Jebel Huwayyah, east of Al Ain.

DISTRIBUTION. Lower Aptian of Austria and Germany (Allgäu Schrätenkalk), Aptian of central Greece, Aptian and Middle Albian of Mexico (Tehuacan, Sonora), Lower Cenomanian of northwestern

Germany, ?Upper Turonian-Lower Coniacian of Austria (Gosau Group).

Family **BRACHYPHYLLIIDAE** Alloiteau, 1952

REMARKS. Since its introduction by Alloiteau (1952a) the systematic position of the family Brachyphylliidae Alloiteau has been discussed. According to Alloiteau (1952a) and Beauvais (1982) this family belongs to the suborder Fungiina Verrill. Wells (1956) did not recognize Brachyphylliidae Alloiteau. However, on the basis of septal development, which seems to correspond closely to the microsolenid and latomeandrid types, the family Brachyphylliidae Alloiteau is grouped here with the suborder Microsolenina.

Genus **BRACHYPHYLLIA** Reuss, 1854

TYPE SPECIES. *Brachyphyllia dormitzeri* Reuss, 1954.

Brachyphyllia felixi sp. nov. Pl. 11, fig. 5

- non 1848 *Pleurocora haueri* Milne Edwards & Haime, tome XI: 312.
- non 1854 *Pleurocora haueri* Milne Edwards & Haime; Reuss: 112, pl. VI, figs 26, 27.
- v*1903a *Brachyphyllia haueri* (Reuss); Felix: 261, pl. XX, fig. 15, text-fig. 29.
- vnon 1903a *Pleurocora haueri* Milne Edwards & Haime; Felix: 261.
- 1905 *Brachyphyllia haueri* (Reuss); Angelis d'Ossat: 200.
- pars 1914 *Brachyphyllia haueri* (Reuss); Felix, pars 5: 32.
- non 1914 *Brachyphyllia haueri* (Reuss); Felix, pars 7: 170.
- non 1914 *Pleurocora haueri* Milne Edwards & Haime; Felix, pars 7: 172.
- 1930 *Brachyphyllia haueri* Felix; Oppenheim: 343, pl. XLVI, figs 1–1b.
- non 1978 *Pleurocora haueri* Milne Edwards & Haime; Turnšek, in Turnšek & Polšak: 155, 173, pl. 11, figs 1–3.

DERIVATIO NOMINIS. In honour of Prof Johannes Paul Felix.

HOLOTYPE. AZ 2527, from SE corner of Jebel Huwayyah, east of Al Ain.

PARATYPES. AZ 929; AZ 2529; AZ 2531; AZ 2537.

DIAGNOSIS. The species is characterized by the corallite diameter which ranges from 4–8 mm and the septal development of 4 to 5 complete septal cycles in 6 systems.

MEASUREMENTS. d: 4–8 (*10) mm; s: 60–up to ca. 100; size of the colony: up to 3 cm in diameter; single polyps in early settling stages: up to 8 mm in diameter.

DESCRIPTION. Plocoid colony with elevated corallites that are circular in outline. Gemmation is due to extracalicular budding. Costosepta are subcompact or compact in older cycles, straight, thin,

PLATE 10

Micrographs of thamnasterioid (1, 2, 4, 8), plocoid (3, 6), and trochoid (5, 7), coralla in transverse and longitudinal thin-sections, and upper surface view.

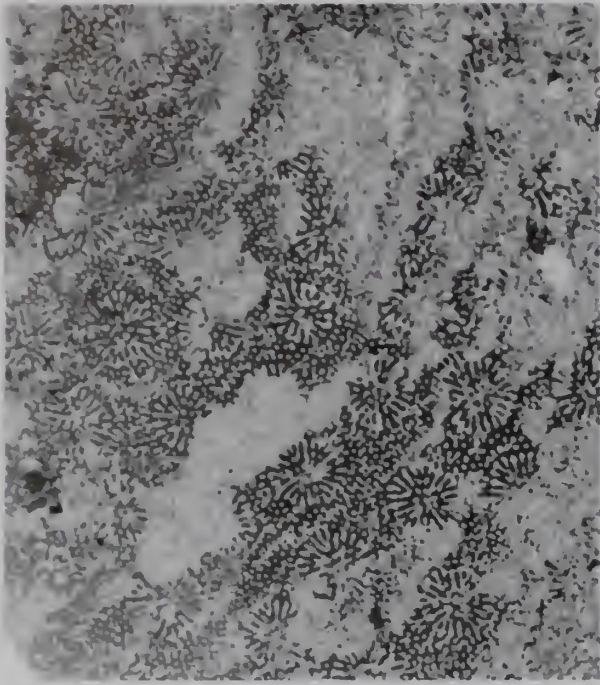
Figs 1, 4 *Aspidastraea orientalis* Kühn, 1933; 1, AZ 188; 4, AZ 636.

Figs 2, 8 *Mesomorpha mammillata* (Reuss, 1854); AZ 904.

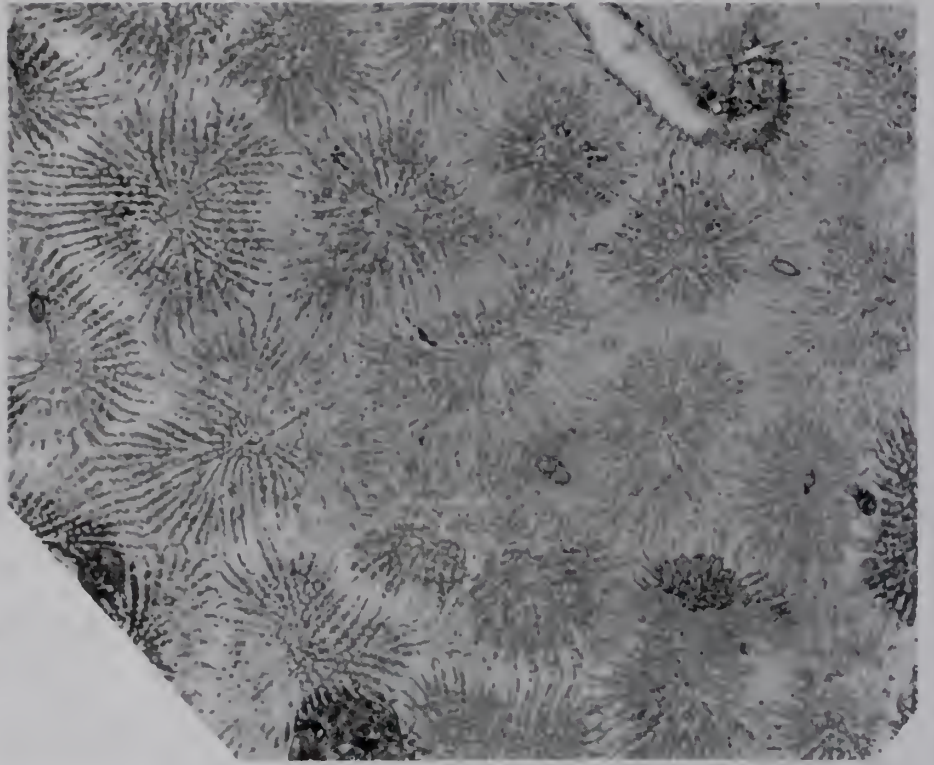
Figs 3, 6 *Actinacis remesi* Felix, 1903; AZ 570.

Figs 5, 7 *Trochocyathus microphytes* Felix, 1903; AZ 795; 5, juvenile stage.

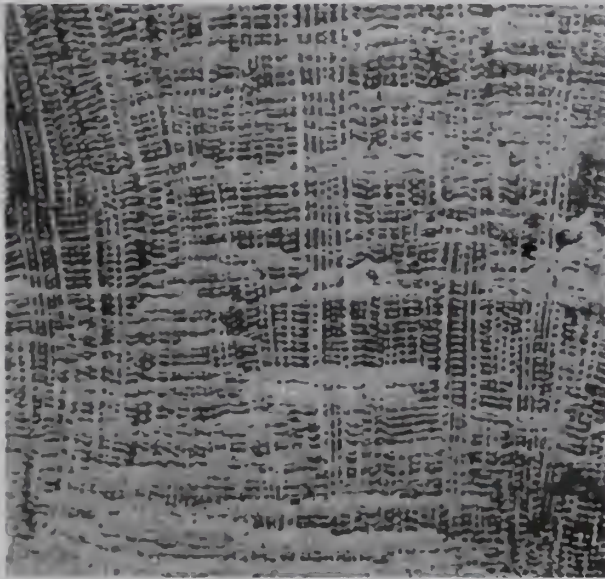
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1



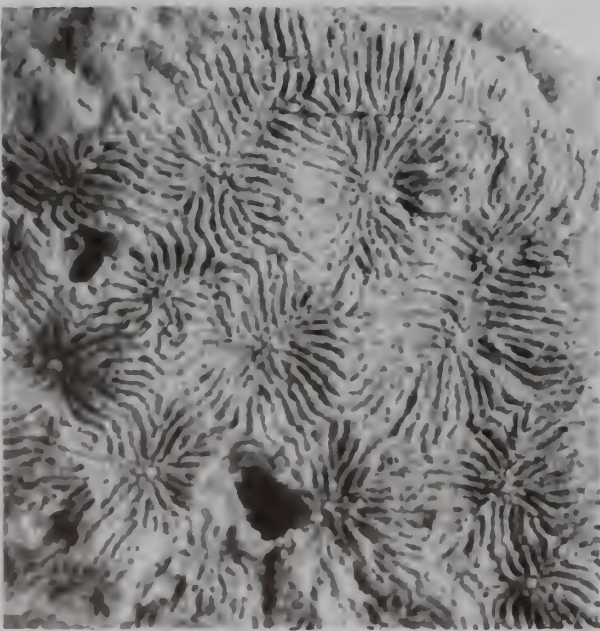
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4

and arranged in 4 to 5 cycles in 6 systems, regularly alternating in length. Septa of the first 3 cycles are nearly equal in thickness. Septa of remaining cycles are distinctly thinner. About 12 septa reach the axial region, sometimes fusing with neighbouring septa or with the spongy-papillose columella. Lateral surfaces of septa are covered by spiny or rounded granules and pennulae. Synapticulae are distributed throughout the colony. The wall is synapticulothecal. Endotheca consists of delicate vesicular dissepiments. In early ontogenetic stages the corallite may be covered by an epithelial wall.

COMPARISON. This new species is intermediate between *Brachyphyllia dormitzieri* Reuss, 1854, and *B. depressa* Reuss, 1854. From *B. dormitzieri* Reuss it is distinguished by the larger diameter of the corallites and the larger number of septa. In *B. dormitzieri* Reuss the corallite diameter ranges from 5 to 6 mm and the number of septa never exceeds 48, corresponding to 4 cycles in 6 systems. From *B. depressa* Reuss the new species differs by the smaller corallite diameter and the septal arrangement in up to 5 complete cycles in regularly developed 6 systems. In *B. depressa* Reuss the corallite diameter ranges from 13 to 18 mm and the septal apparatus follows the arrangement in 6 systems only in the first 4 cycles.

REMARKS. According to Felix (1903a: 261) the specimen that Reuss (1854: 112) assigned to *Pleurocora haueri* Milne Edwards & Haime represents a species of the genus *Brachyphyllia*. Instead of giving a new specific name, Felix just excluded Reuss's specimen from the synonymy of the species by Milne Edwards & Haime and referred to Reuss as first author, creating the form *Brachyphyllia haueri* (Reuss). Oppenheim's (1930) revision showed that *Brachyphyllia haueri* (Reuss) in Felix (1903a) did not correspond to *Pleurocora haueri* Milne Edwards & Haime in Reuss (1854). According to Oppenheim's studies Reuss's specimen represents a species of *Pleurocora*, but the form described by Felix belongs to the genus *Brachyphyllia*. Oppenheim tried to solve this problem by keeping the name of the taxon created by Felix (*Brachyphyllia haueri*) and naming him as first author of this species. However, because this is not an allowable taxonomic procedure, a new specific name has to be proposed.

OCCURRENCE. *Loftusia* beds, coral clast horizon, SE corner of Jebel Huwayyah, east of Al Ain.

DISTRIBUTION. Aptian of northern Spain (Catalonia), Santonian-Campanian of Austria (Gosau Group).

Family CUNNOLITIDAE Alloiteau, 1952a

Genus CUNNOLITES Barrère, 1746

TYPE SPECIES. *Porpites ellipticus* Guettard, 1774 (= *Cyclolites elliptica* Lamarck, 1801).

Cunnolites sp.

Pl. 5, figs 2, 4

MATERIAL. AZ 98–101, AZ 103, AZ 107, AZ 109, AZ 113–14, AZ 116, AZ 128, AZ 135–38, AZ 140–42, AZ 147, AZ 150, AZ 153–54, AZ 159–60, AZ 169–70, AZ 207, AZ 215–16, AZ 220, AZ 222–24,

AZ 232–33, AZ 235–40, AZ 243, AZ 245, AZ 247, AZ 250–51, AZ 254, AZ 264–65, AZ 268, AZ 277–78, AZ 281–82, AZ 284, AZ 291, AZ 293–94, AZ 300–01, AZ 305–06, AZ 308–09, AZ 311, AZ 313, AZ 325, AZ 334, AZ 339, AZ 349, AZ 362, AZ 369–70, AZ 373, AZ 384, AZ 393–94, AZ 397, AZ 400, AZ 436, AZ 439–40, AZ 444–45, AZ 447, AZ 484–85, AZ 487–89, AZ 495, AZ 498–99, AZ 501, AZ 505a, AZ 506, AZ 508–11, AZ 519, AZ 640, AZ 740–41, AZ 743, AZ 746–47, AZ 749–50, AZ 752–53, AZ 755, AZ 758–60, AZ 762–63, AZ 766–67, AZ 769–71, AZ 773, AZ 775–77, AZ 779, AZ 803, AZ 805, AZ 807–08, AZ 817–19, AZ 821–23, AZ 826, AZ 830–31, AZ 834, AZ 837–41, AZ 844, AZ 846, AZ 851, AZ 853–61, AZ 864–70, AZ 872–74, AZ 877–78.

MEASUREMENTS. d (max) (D): 9–118 mm; d (min) (d): 9–80 mm; height of corallum (h): 3–30 mm; s/ mm (on upper surface of specimen, near central pit): 5/ 2; s/ mm (in peripheral areas of the specimen): 6–8 (*10)/ 2.

DESCRIPTION. The corallum is simple, free, circular or elliptical in outline. The base is flat or concave and can be partly or completely covered by a concentrically wrinkled epitheca. The corallum is convex above with an elongated or circular fossa. Septa are straight, moderate and subequal in thickness, porous or subcompact, and covered with numerous granules and pennulae laterally. According to the length 5 to 7 orders of septa can be distinguished. The density of septa varies from 5 in 2 mm in regions near the central pit to 6–8 (10) in 2 mm in peripheral areas. There is no columella. Thin endothecal dissepiments are present. Synapticulae are very abundant. The wall is synapticulothecal. Microstructure is poorly preserved, but in places thick compound trabeculae are present.

REMARKS. Studies on specimens of *Cunnolites* from the Campanian of Spain by Baron-Szabo (1998) showed that dimensions of skeletal elements cannot be used as specific characters for this genus, thus corresponding to the situation with *Diploctenium*. Therefore, the specimens of the UAE/ Oman are not assigned to any species. For further characterization of the population see Fig. 7.

OCCURRENCE. *Loftusia* Level, main coral beds (beds 5, 7, 10/ 11), Jebel Huwayyah, east of Al Ain; *Trigonia/Pachymya* Bed, 3 km east of Jebel Rawdah, east of Al Madam, and below *Trigonia/Pachymya* Bed (bed 9); Qahlah Formation, 16 km east of Madam Roundabout; main gastropod level (beds 7–8), north side of Jebel Bu Milh, 25 km NE of Hili; east face of most northern hill forming Jebel Buhays, 4 km north of Al Madam (loose beds 4–11); Simsima Formation or loose, derived from lowest 3–4 m of section, NE side of Jebel Thanais, 4 km north of Al Madam; SW corner (beds 3–5) and SE corner (bed 10, unit 9) of Jebel Huwayyah, east of Al Ain; Simsima Formation (Lower scree and higher), 3 km east of Jebel Rawdah, east of Al Madam; Simsima Formation (loose, from beds 18–19), 2 km east of Jebel Rawdah, east of Al Madam; Qahlah Formation, *Loftusia* Beds (beds 10/ 11), SE corner of Jebel Huwayyah, east of Al Ain; outcrop on east face, ca. 3 km north of the southern tip of Jebel Faiyah, NNE of Al Madam; base of Simsima Formation (bed 14), SE corner of Jebel Huwayyah, east of Al Ain; above *Zuffardia* level (beds 10–13, 15, 19), north side of valley, ca. 2 km east of Jebel

PLATE 11

Micrographs of plocoid (1, 3, 5) and thamnasterioid (2, 4) coral colonies in transverse and longitudinal thin-sections, and upper surface view.

Figs 1, 3 *Actinacis parvistella* Oppenheim, 1930; AZ 641.

Fig. 2 *Brachycoenia leptophylla* (Reuss, 1854); AZ 476.

Fig. 4 *Fungiastraea crespoidi* (Felix, 1891); AZ 642.

Fig. 5 *Brachyphyllia felixi* sp. nov.; juvenile polyps in early settling stages of incipient colonies (arrow); AZ 2527.

Scale bar = 3 mm.

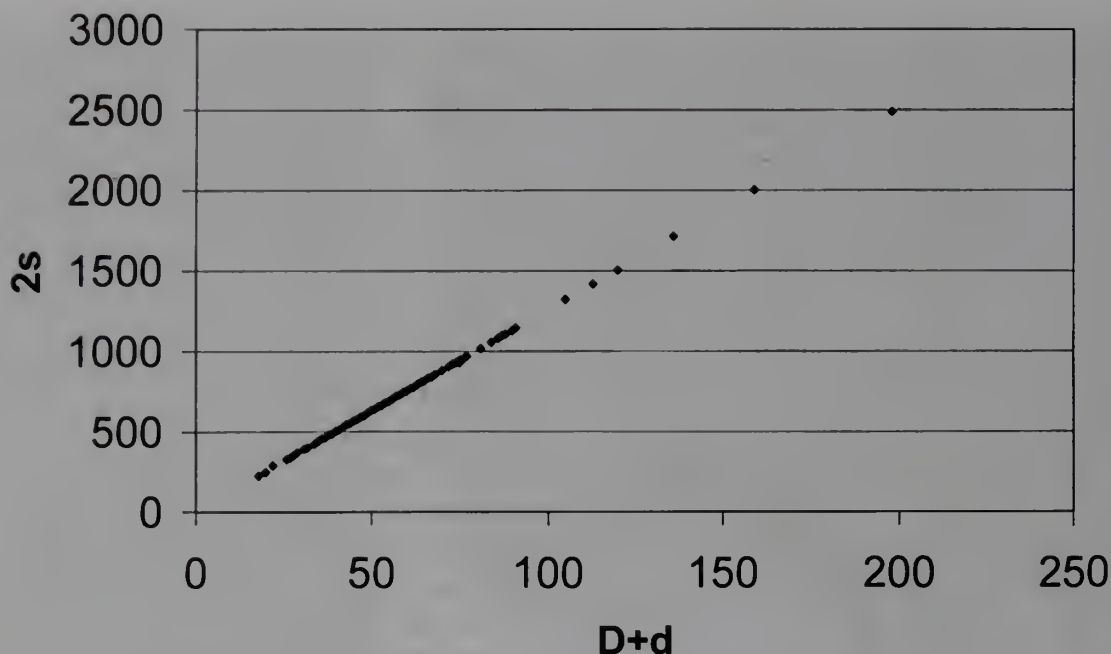


Fig. 7 The ratio of number of septa (2s) to the average diameter (D+d) for the specimens of *Cunolites* sp: the points form a single gradient suggesting that the population consists of a single species. However, according to the current classification, species of *Cunolites* also differ in height of corallum, size of calicular pit, etc., which obviously do not correspond to the number of septa nor to the size of the calicular diameter. Therefore, several species might be present in this population.

Rawdah, east of Al Madam; north side of valley, ca. 3 km east of Jebel Rawdah, east of Al Madam;

Genus *ASPIDASTRAEA* Kühn, 1933

TYPE SPECIES. *Aspidastraea orientalis* Kühn, 1933.

Aspidastraea orientalis Kühn, 1933 Pl. 5, fig. 6, Pl. 10, figs 1, 4

- v*1933 *Aspidastraea orientalis* Kühn: 179; pl. XVII, fig. 7.
 1943 *Aspidastraea orientalis* Kühn; Vaughan & Wells: 135.
 1952a *Aspidastraea orientalis* Kühn; Alloiteau: 668.
 1956 *Aspidastraea orientalis* Kühn; Wells: F387, fig. 280,3.
 1987 *Aspidastraea orientalis* Kühn; Kuzmicheva: 87, pl. V, fig. 5.

MATERIAL. AZ 156; AZ 176–81; AZ 184–202; AZ 211–12; AZ 252; AZ 336; AZ 348; AZ 496; AZ 636; AZ 812–14.

MEASUREMENTS. c–c (adjacent series): 3–5.5 (*7) mm; c–c (same series): (*1.5) 2.5–5 mm; 16–28, main corallite: up to 60; s/mm: 16–20/ 5; h: 5–25 mm; size of the colony: 18–53 mm in diameter.

DESCRIPTION. The corallum is in the form of a free colony, circular or slightly elliptical in outline. The base is flat or insignificantly concave, and is covered by a concentrically wrinkled epitheca. The corallum is convex above with corallites which are produced by circumoral budding. In general, one central calice is present, which appears to be larger. Rarely, two main calices may occur, or the size of the main calice might be reduced, closely corresponding to

dimension of the non-dominant corallites. Septa are straight or wavy, moderate and subequal in thickness, porous or subcompact, and covered with numerous granules and pennulae laterally. About 10 septa reach the centre of the calice. In the main calice up to 30 septa may extend to the axial region. The central part of the corallites can be free or filled with a trabecular columella. Thin endothecal dissepiments are present. Synapticulae are very abundant. There is no wall between the corallites.

REMARKS. The specimens of the UAE/ Oman very closely agree with the type material of *Aspidastraea orientalis* Kühn.

OCCURRENCE. NW end of Jebel Bu Milh (beds 3/4), 25 km NE of Hili; Simsima Formation (beds 15–19) or loose from middle part of section north side of valley, about 2 km east of Jebel Rawdah, east of Al Madam; east face of most northern hill forming Jebel Buhays (beds 4–11), 4 km north of Al Madam; above *Zuffardia* level (beds 13, 15, 19), north side of valley, ca. 2 km east of Jebel Rawdah, east of Al Madam; Simsima Formation (bed 15), 16 km east of Madam Roundabout; north side of valley, 3 km east of Jebel Rawdah, east of Al Madam.

DISTRIBUTION. Turonian of Armenia, Senonian of Iran.

Aspidastraea semhae (Kossmat, 1907) Pl. 12, figs 2, 4, 5

- *1907 *Aspidiscus semhae* Kossmat: 54, pl. V, figs 9a–c.
 1918 *Aspidiscus semhae* Kossmat; Fossa-Mancini: 145, pl. XIV [I], figs 10a, b.
 1922 *Aspidiscus semhae* Kossmat; Hoppe: 72.
 1930 *Aspidiscus semhae* Kossmat; Renz: 10.

PLATE 12

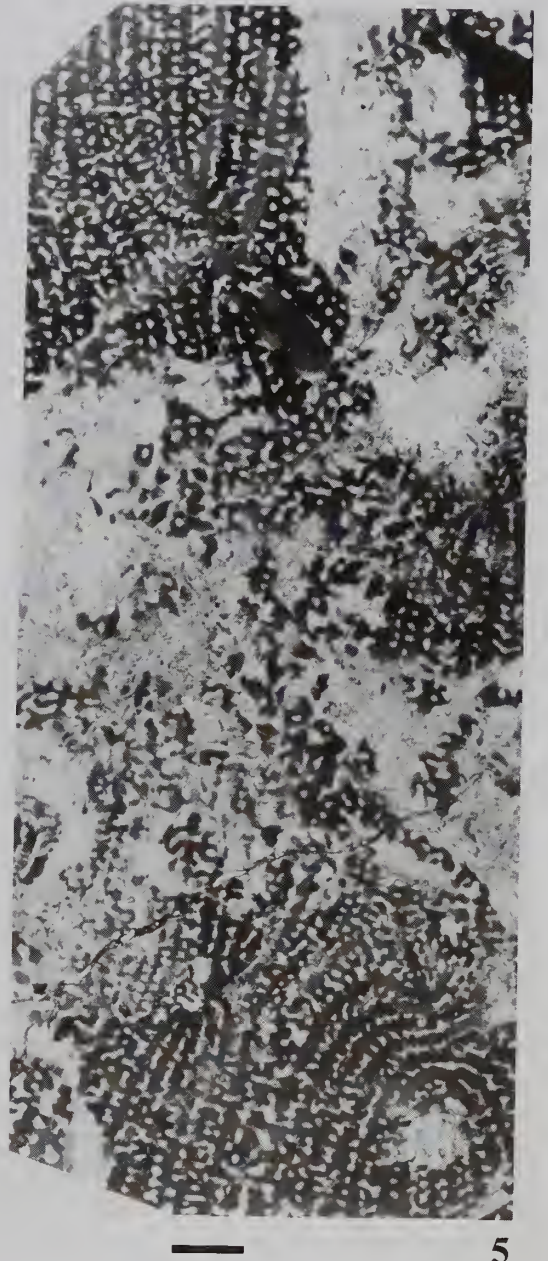
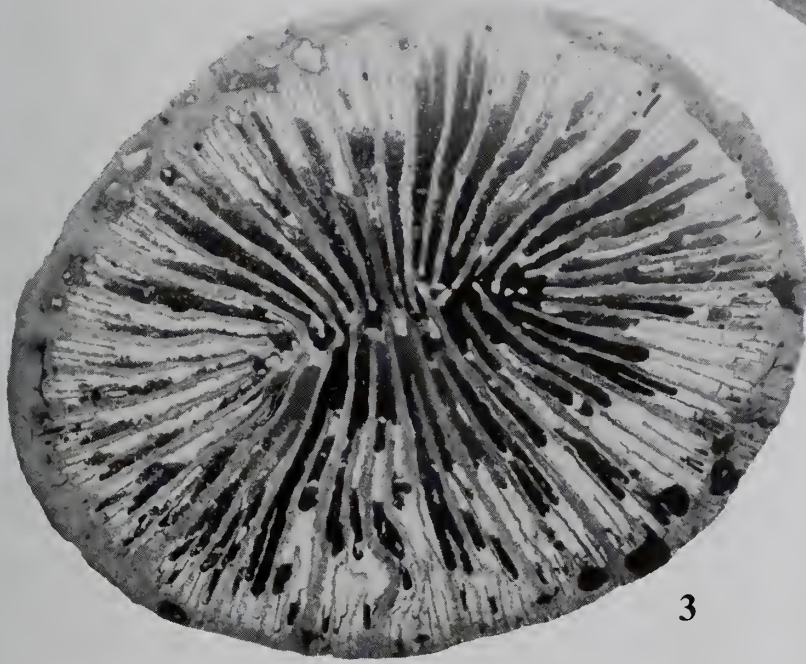
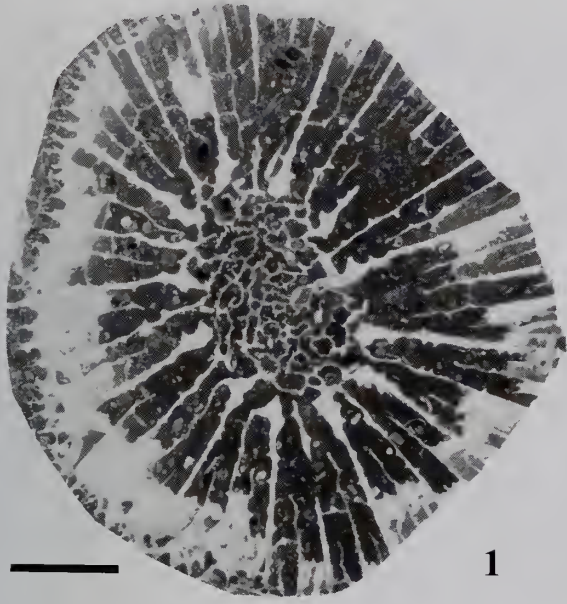
Micrographs of trochoid (1, 3) and thamnasterioid (2, 4, 5) coralla in transverse thin-sections and upper surface view.

Fig. 1 *Diegosmilia complanata* (Collignon, 1931); AZ 66.

Figs 2, 4, 5 *Aspidastraea semhae* (Kossmat, 1907); 2, juvenile form, AZ 407; 4, AZ 411; 5, AZ 572.

Fig. 3 *Trochocyathus microphytes* Felix, 1903; AZ 69.

Scale bar = 3 mm.



4

5

- 1931 *Aspidiscus semhae* Kossmat; Renz: 5.
 1933 *Aspidastraea semhae* (Kossmat); Kühn: 180.

MATERIAL. AZ 402; AZ 407; AZ 411; AZ 572.

MEASUREMENTS. c-c (same series): 2–8 (*10) mm; c-c (adjacent series): 6–10 (*14) mm; s/mm: 9–12 (*16)/5; size of the colony: 3.5 × 4.5 cm to 13 × 23 cm.

DESCRIPTION. The corallum is in the form of a free colony, very elongated in outline. The base is flat or slightly concave, and can be covered by a smooth epitheca. The corallum is convex above. Corallites are arranged in circumoral rows. In general, no central calice is present. In juvenile forms slightly dominant central corallites may be present. Septa are thick, straight or wavy, equal in thickness, and porous or subcompact. Their lateral sides are covered with numerous pennulae and granules, varying in size and shape. Twelve to 24 septa reach the centre of the calice. The axial part of the corallites can be free or filled with a trabecular columella. The endotheca consists of thin dissepiments. Synapticulae are very abundant. There is no wall between the corallites. Microstructural features are not preserved.

OCCURRENCE. *Loftusia* Level, main corals bed, SW corner of Jebel Huwayyah, east of Al Ain.

DISTRIBUTION. Cenomanian of the Arabian Gulf (Sokrota Island), Senonian of Iran.

Suborder **CARYOPHYLLIINA** Vaughan & Wells, 1943

Family **PARASMILIIDAE** Alloiteau, 1952

Subfamily **PARASMILIINAE** Vaughan & Wells, 1943

Genus **DIEGOSMILIA** Alloiteau, 1958

TYPE SPECIES. *Microseris complanata* Collignon, 1931.

Diegosmilia complanata (Collignon, 1931) Pl. 12, fig. 1

- *1931 *Microseris complanata* Collignon: pl. V (I), figs 4–5b.
 1958 *Diegosmilia complanata* (Collignon); Alloiteau: 153, pl. XXXIV, figs 5, 6, text-fig. 25.

MATERIAL. AZ 64; AZ 66.

MEASUREMENTS. d: 14–15 mm; s: 12s1+12s2+24s3+s; h: 35–50 mm.

DESCRIPTION. The corallum is simple and trochoid, circular in outline. Costosepta are compact, have spiniform and thick rounded granules laterally, and are arranged in 3 orders with the beginning of a fourth one. The first order consists of 12 thickest septa, extending to the centre of the calice. The second order, including 12 septa, can be equal in length but are distinctly thinner. The third order is formed by 24 septa, reaching about half or three quarters the length of the higher order septa. Last order septa are significantly thinner and shorter. The columella is irregularly spongy-trabecular and fused with trabecular prolongations of inner ends of septa of the first two orders. The wall is parathecal. Endotheca consists of vesicular dissepiments.

REMARKS. The specimens from the UAE/ Oman closely agree with the descriptions and illustrations of the type material in Alloiteau (1958: 153–154).

OCCURRENCE. *Loftusia* beds (beds 3–8), SW corner of Jebel Huwayyah, east of Al Ain.

DISTRIBUTION. Cenomanian of Madagascar.

Family **CARYOPHYLLIIDAE** Dana, 1846

Subfamily **CARYOPHYLLIINAE** Milne Edwards, 1857

REMARKS. Commonly, Gray (1847) is being referred to as the first author to have described the family Caryophylliidae (e.g. Milne Edwards, 1857; Vaughan & Wells, 1943; Alloiteau, 1952). However, as pointed out by Cairns (1989) one year prior to Gray's work the family Caryophylliidae was created by Dana (1846: 364), thus giving the latter priority of authorship.

Genus **TROCHOCYATHUS** Milne Edwards & Haime, 1848

TYPE SPECIES. *Turbinolia mitrata* Goldfuss, 1826.

REMARKS. The variability of a large number of characteristics (e.g. columella, pali, thickness of septa) in the genus *Trochocyathus* was previously recognized by Milne Edwards & Haime (1848: 300). Later, Alloiteau (1958) used these features to divide *Trochocyathus* into three independent groups: *Trochocyathus*, *Protrochocyathus*, and *Paratrochocyathus*. According to Kühn (1966: 339) these characteristics are not sufficient for separation at genus level. Recent studies carried out by Cairns (1997) support this idea. Based on cladistic analysis on turbinoliid genera Cairns (1997) concluded that less taxonomic weight should be given to characters such as columella and pali. These results suggest that those skeletal elements are of minor taxonomic value, thus strongly agreeing with the idea proposed for *Trochocyathus* by Milne Edwards & Haime. Therefore, the author considers *Protrochocyathus* Alloiteau and *Paratrochocyathus* Alloiteau as younger synonyms of *Trochocyathus* Milne Edwards & Haime.

Trochocyathus microphyes Felix, 1903

Pl. 10, figs 5, 7, Pl. 12, fig. 3

- *1903a *Trochocyathus microphyes* Felix: 354, pl. XVIII, figs 9, 10.
 1914 *Trochocyathus microphyes* Felix; Felix, pars 7: 209.
 1930 *Trochocyathus micraphye* Felix; Oppenheim: 548.

MATERIAL. AZ 61; AZ 63; AZ 69–70; AZ 77; AZ 81; AZ 482; AZ 780–83; AZ 786; AZ 792–93; AZ 795.

MEASUREMENTS. d (max) (D): 22–41 mm; d (min) (d): 17–30 mm; s: 120–180; h: 25–65 mm; d/D: 0.7–0.89; juvenile stage (measured in about 4 mm height): d: 4–7 mm; s: 48 (12+12+24).

DESCRIPTION. The corallum is simple and turbinate, trochoid or ceratoid. The corallite is elongated or compressed. Costosepta are compact, thin or moderate, straight or slightly curved, finely granulated laterally, and arranged in 5 complete with the beginning of a

PLATE 13

Micrographs of massive octocorals with calicinal tubes in transverse (1, 4) and longitudinal (2, 3) thin-sections.

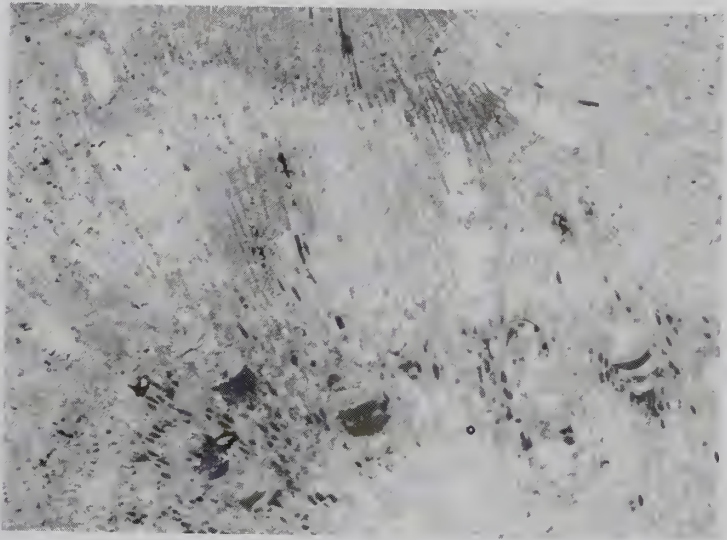
Figs 1, 2 *Polytremacis edwardsana* (Stoliczka, 1873); AZ 561.

Figs 3, 4 *Polytremacis blainvillei* (Michelin, 1841); AZ 965.

Scale bar = 3 mm.



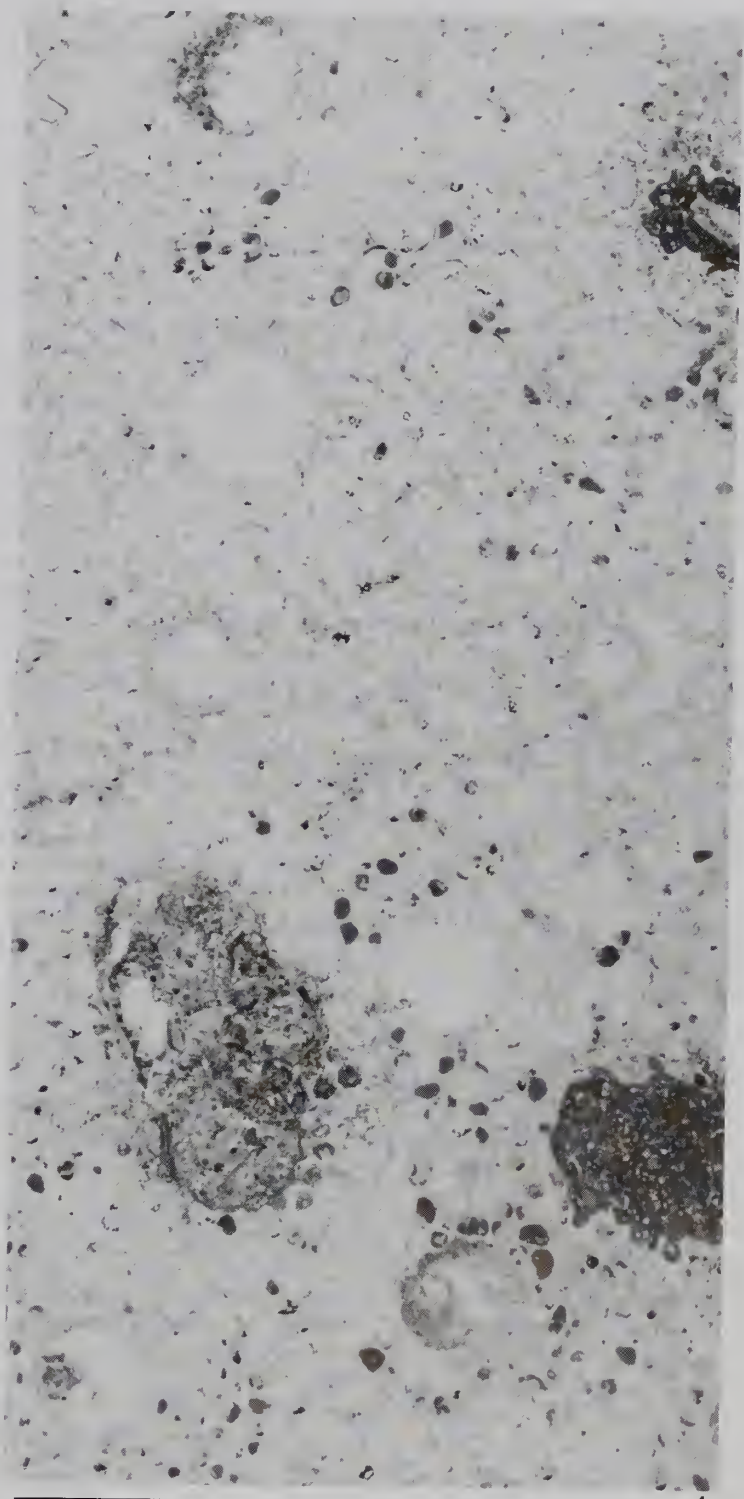
1



2



3



4

sixth cycle in 12 systems. In general, septa regularly alternate in thickness. Inner ends of septa of the first 3 cycles terminate in very elongated paliform structures. In younger septa development of paliform features may be perceptible or not present. The columella is very variably shaped: spongy-papillose, or fused papillae may form elongated segments, or it may be very weakly developed (trabecular). Wall is septothecal. Endotheca consists of vesicular dissepiments.

REMARKS. The juvenile stage of the specimens (measured in about 4 mm height of the coralla) very closely correspond to the description and illustration of *Trochocyathus microphytes* Felix, which has a calicular diameter of 5 mm and a height of 3 mm. It is suggested that the specimens of the UAE/ Oman represent ontogenetically older stages of this species. The nature of the very elongated paliform structures have been previously well illustrated by Alloiteau (1958: 131, fig. 21; Baron-Szabo, 1998: pl. 7, fig. 4).

OCCURRENCE. Qahlah Formation, *Loftusia* beds, SW corner of Jebel Huwayyah, east of Al Ain.

DISTRIBUTION. Santonian of Austria (Gosau Group)

Subclass **OCTOCORALLIA** Haeckel, 1866
Order **COENOTHECALIA** Bourne, 1900
Family **HELIOPORIDAE** Moseley, 1876
Genus **POLYTREMACIS** d'Orbigny, 1849

TYPE SPECIES. *Heliopora blainvilleana* Michelin, 1841.

Polytremacis blainvillei (Michelin, 1841) Pl. 13, figs 3, 4

- *1841 *Heliopora blainvilleana* Michelin: 27, pl. VII, fig. 6a, b.
- 1850 *Polytremacis blainvilleana* (Michelin); d'Orbigny, tome II: 209.
- non 1854 *Polytremacis blainvilleana* (Michelin); Reuss: 131, pl. XXIV, figs 4–7.
- non 1903a *Polytremacis blainvilleana* (Michelin); Felix: 356.
- non 1956 *Polytremacis blainvilleana* (Michelin); Bendukidze: 119.
- 1957 *Polytremacis blainvillei* (Michelin); Alloiteau: 378–381.

MATERIAL. AZ 459; AZ 525; AZ 527; AZ 588; AZ 885; AZ 930; AZ 965.

MEASUREMENTS. d: (*0.8) 1.1–1.6 (*1.8) mm; c–c: 1.5–5 mm; s: 14–18 (21); tubes/ mm²: 17–21; size of the colony: 3–20 cm in diameter.

DESCRIPTION. The colony is massive or nodular. Calicinal tubes are circular or slightly elongated in outline and imbedded in a vermiculate exoskeleton, composed of very small rounded or elliptical tubes. Septa are very short and thorn-like. Calicular tabulae are well-developed, tabulate or slightly arched.

REMARKS. According to Beauvais (1982, tome I: 39), in having a very unequally developed septal apparatus with generally large septa the specimens assigned to *Polytremacis blainvilleana* (Michelin) by Reuss (1854), Felix (1903a), and Bendukidze (1956) represent forms of the genus *Parapolytremacis* Alloiteau (1957: 381).

OCCURRENCE. *Loftusia* Beds, Qahlah Formation, east side of U-shaped Jebel, 10 km NE of Al Ain; east face of most northern hill forming Jebel Buhays, 4 km north of Al Madam, partly loose, derived from 3–4 m of section (beds 4–11); *Loftusia* Beds, Qahlah

Formation, SE corner of Jebel Huwayyah, east of Al Ain; outcrop at southern tip of Jebel Faiyah, 6 km NNE of Al Madam.

DISTRIBUTION. Turonian of France.

Polytremacis edwardsana (Stoliczka, 1873) Pl. 13, figs 1, 2

- *1873 *Heliopora edwardsana* Stoliczka: 53, pl. XI, fig. 11.
- 1900 *Heliopora edwardsi* Stoliczka; Gregory: 299.
- 1911 *Heliopora tenera* Trauth: 169, text-fig. 6, pl. IV, fig. 3.
- 1914 *Heliopora edwardsi* Stoliczka; Felix, pars 6: 141.
- 1914 *Heliopora tenera* Trauth; Felix, pars 7: 248.
- 1936 *Heliopora edwardsana* Stoliczka; Hackemesser: 76, pl. 6, fig. 11.
- 1964 *Polytremacis edwardsana* (Stoliczka); Morycowa: 55, pl. XII, figs 1a–e.
- 1971 *Polytremacis tenera* (Trauth); Morycowa: 136, fig. 41, pl. XL, fig. 1.
- 1981 *Polytremacis edwardsana* (Stoliczka); Scott: 465.
- 1982 *Polytremacis tenera* (Trauth); Beauvais, tome III: 36, pl. LIII, fig. 7, pl. LVIII, fig. 5.
- 1997a *Polytremacis edwardsana* (Stoliczka); Eliášová: 69, pl. VIII, figs 1, 2.
- v1998 *Polytremacis edwardsana* (Stoliczka); Baron-Szabo: 154, pl. 1, fig. 7.

MATERIAL. AZ 561; AZ 886.

MEASUREMENTS. d: 0.6–0.9 (*1.1) mm; c–c: 1.5–4 mm; s: 14–18; tubes/ 1 mm²: 19–25; size of the colony: up to 15 cm in diameter.

DESCRIPTION. The colony is massive, knobby or lamellar, with calicinal tubes which are circular or slightly elongated in outline. They are embedded in a vermiculate exoskeleton, composed of very small rounded or elliptical tubes. Septa are very short and thorn-like. Calicular tabulae are well-developed and slightly arched.

REMARKS. The descriptions and illustrations of the species *Polytremacis tenera* (Trauth) closely agree with *Polytremacis edwardsana* (Stoliczka), suggesting that they are synonymous. Moreover, the specimens described from Spain (Baron-Szabo, 1998) as well as the specimens at hand unite characteristics of both species.

OCCURRENCE. East face of most northern hill forming Jebel Buhays, 4 km north of Al Madam.

DISTRIBUTION. Barremian-Lower Aptian of Poland, Lower Aptian of Romania, Lower Albian of Mexico and Arizona (Mural Limestone), ?Cenomanian of Greece, Cenomanian (?-Turonian) of India, Upper Cenomanian and Senonian of the Czech Republic, Santonian-Campanian of Austria (Gosau Group), Upper Santonian of southern France, Campanian of northern Spain (Catalonia).

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REFERENCES

- Alloiteau, J. 1941. Révision de collection H. Michelin. Polypiers d'anthozoaires fossiles (1); Crétacé. *Mémoires du Muséum National d'Histoire Naturelle*, (NS) 16 (1): 1–100.

- 1952a. Embranchement des Coelentérés. II. Madréporaires post-paléozoïques. In Piveteau, J. (editor), *Traité de Paléontologie*, 1: 539–684. Masson, Paris.
- 1952b. Sur la genre *Diploctenium* Goldfuss dans le Crétacé supérieur français. *Bulletin de la Société géologique de France*, (6) 2: 537–573.
- 1954. Le genre *Actinastrea* d'Orbigny, 1849 dans le Crétacé supérieur français. *Annales Hébert et Haug*, 8: 9–104.
- 1957. Contribution à la systématique des Madréporaires fossiles. *Thèse Centre National Recherche Scientifique*. 462 pp. Paris.
- 1958. Monographie des Madréporaires fossiles de Madagascar. *Annales Géologiques de Madagascar*, 25: 118 pp.
- Angelis d'Ossat, G. de** 1905. Coralli del Cretacico inferiore della Catalonia. *Palaeontographica Italica*, 11: 169–251.
- d'Archardi, A.** 1875. Coralli eocenici del Friuli. *Atti della Societa Toscana di Scienze Naturali residente in Pisa*, 1: 67–86.
- Baron-Szabo, R. C.** 1997. Zur Korallenfazies der ostalpinen Kreide (Helvetikum): Allgäuer Schrattekalk; Nördliche Kalkalpen: Brandenberger Gosau), Taxonomie, Paläökologie. *Zitteliana*, 21: 3–98.
- 1998. A new coral fauna of the Campanian from north Spain (Torallola village, Prov. L'lèida). *Geologisch-Paläontologische Mitteilungen Innsbruck*, 23: 127–191.
- 1999. Upper Cretaceous scleractinian corals of the Gosau Group (Weissenbachalm, Steiermark, Austria). *Abhandlungen der geologischen Bundesanstalt Wien, Festschrift zum 150-jährigen Jubiläum* 24 pp.
- (in preparation). Maastrichtian corals from Jamaica.
- & **Steuber, T.** 1996. Korallen und Rudisten aus dem Apt im tertiären Flysch des Parnass-Gebirges bei Delphi-Arachowa (Mittelgriechenland). *Berliner Geowissenschaftliche Abhandlungen (E)* 18: 3–75.
- Barrère, P.** 1746. *Observations sur l'origine et la formation des pierées figurées et sur celles qui, tant extérieurement, qu'intérieurement, ont une figure régulière et déterminée*. 67 pp. Paris.
- Bataller, J. R.** 1937. La fauna corallina del Cretacico de Catalunya i regions limitrofes. *Actius de l'Escola superior d'Agricultura, Nova ser.*, 8 (1), 1–299.
- Beauvais, L. & Beauvais, M.** 1974. Studies on the world distribution of the Upper Cretaceous corals. *Proceedings of the 2nd International Corals Reef Symposium, Brisbane*, 1: 475–494.
- & — 1975. Une nouvelle famille dans le sous-ordre des Stylinida Alloiteau: les Agatheliidae nov. fam. (Madréporaires mésozoïques). *Bulletin de la Société géologique de France*, (7) 17 (4): 576–581.
- Beauvais, M. P.** 1982. Révision systématique des Madréporaires des couches de Gosau (Crétacé supérieur, Autriche). *Travaux du Laboratoire de Paléontologie des Invertébrés*, 1–5. Paris.
- , **Berthou, Y. & Lauerjat, J.** 1975. Le gisement campanien de Mira (Beira litorale, Portugal): sédimentologie, micropaléontologie, révision des Madréporaires. *Comunicações dos Serviços Geológicos de Portugal*, 59: 37–58.
- Bendukidze, N. S.** 1956. Upper Cretaceous corals from the Godogani and Udzlouri areas. *Trudy Geologicheskogo Instituta Akademiyi Nauk Gruzinskoy SSR, (Seriya Geologiya)*, 9 (2): 79–125.
- 1965. To the ecology, ontogeny and systematics of the genus *Diploctenium*. In Sokolov, B.S. & Ivanovskiy, A. B. (editors), *Skleraktinii mezozoya SSSR (Trudy 1 Vsesoyuznogo simpoziuma po izucheniyu iskopayemykh korallov, 4)*, 20–24. Moskva (Nauka).
- Blainville, H. M. de** 1830. *Dictionnaire des Sciences naturelles: Zoophytes*. LX: 274–364. F.G. Levrault, Paris.
- Bosellini, F.** 1999. The scleractinian genus *Hydnophora* (revision of Tertiary species). *Paläontologische Zeitschrift*, 73 (4): 217–240.
- & **Baron-Szabo, R. C.** (in preparation). Revision of Cretaceous and Tertiary hydnothoroid corals.
- Bourne, G. C.** 1900. *Anthozoa*. In Lankester, R. (editor), *Treatise on Zoology*, II. London.
- Bruguière, J. G.** 1792. Description d'une nouvelle espèce de Madrépore. *Journal d'Histoire naturelle rédigé par M.M. Lamarck, Bruguière Oliver, Hauy et Pelletier*, 1: 461 pp. Paris.
- Cairns, S. D.** 1989. A revision of the ahermatypic Scleractinia of the Philippine Islands and adjacent waters, Part 1: Fungiacyathidae, Micrabaciidae, Turbinoliinae, Guyniidae, and Flabellidae. *Smithsonian Contributions to Zoology*, 486: 136 pp.
- 1997. A generic revision and phylogenetic analysis of the Turbinoliidae (Cnidaria: Scleractinia). *Smithsonian Contribution to Zoology*, 591: 36 pp. Smithsonian Institution Press, Washington, D.C.
- Collignon, M.** 1931. La fauna du Cénomaniien à fossiles pyriteux du Nord de Madagascar. *Annales Géologiques de Madagascar*, 20: pl. V (1), figs 4–5b.
- Dainelli, G.** 1915. *L'Eocene friulano: monografia geologica e paleontologica*. 721 pp.
- Dana, J. D.** 1846. Zoophytes. *United States Exploring Expedition during the years 1838–1842 under the command of Charles Wilkes, U.S.N.*, 1–2: 740 pp. Lea & Blanchard, Philadelphia.
- Dietrich, W. O.** 1926. Steinkorallen des Malm und der Unterkreide im südlichen Deutsch-Ostafrika. *Palaeontographica*, 1 (Supplement 7): 43–62.
- Drobne, K., Ogorelec, B., Plenicar, M., Zucchi-Stoffa, M. L. & Turnšek, D.** 1988. Maastrichtian, Danian and Thanetian beds in Dolenja Vas (NW Dinarids, Yugoslavia). Microfacies, foraminifers, rudists, and corals. *Razprave Slovenska Akademija Znanosti in Umetnosti (4)*, 29 (6): 147–224.
- Duncan, P. M.** 1880. A monograph of the fossil corals and Alcyonaria of Sind. *Memoir of the Geological Survey of India, Palaeontologia Indica, ser. XIV*, 1 (1): 110 pp.
- Ehrenberg, C. G.** 1834. *Die Corallenthiere des Rothen Meeres physiologisch untersucht und systematisch verzeichnet*. 156 pp. Berlin.
- Elišová, H.** 1989. Les Madréporaires du Crétacé supérieur de la Montagne de Beskydy (Tchécoslovaquie). *Zapadne Karpaty, Paleontologia*, 13: 81–107.
- 1991. Révision du genre *Glenarea* Pocta (Scleractiniaire du Cénomaniien supérieur-Turonien inférieur de la Bohème, Tchécoslovaquie). *Casopis pro Mineralogii a Geologii*, 36 (2–3), 97–102.
- 1992. Archaeocoeniina, Stylinina, Astraeoinea, Meandriina et Siderastraeidae (Scleractiniaires) du Crétacé de Bohême (Cénomaniien supérieur-Turonien inférieur; Turonien supérieur, Tchécoslovaquie). *Vestník Ceskeho geologickeho ústavu*, 67 (6): 399–414.
- 1997a. Coraux pas encore décrits ou redécrits du Crétacé supérieur de Bohême. *Vestník Ceskeho geologickeho ústavu*, 72 (1): 61–79.
- 1997b. Coraux crétacés de Bohême (Cénomaniien supérieur; Turonien inférieur-Coniacien inférieur), République tchèque. *Vestník Ceskeho geologickeho ústavu*, 72 (3): 245–265.
- Errenst, Ch.** 1990. Das korallenführende Kimmeridgium der nordwestlichen iberischen Ketten und angrenzender Gebiete. *Palaeontographica A*, 214 (3–6): 121–207.
- Esper, E. J. C.** 1797. *Die Pflanzthiere*. 1 (Fortsetzung): 169–230. Raspe, Nürnberg.
- Felix, J. P.** 1884. Korallen aus ägyptischen Tertiärbildungen. *Zeitschrift der Deutschen Geologischen Gesellschaft*, 36: 415–453.
- 1891. Versteinerungen aus der mexicanischen Jura- und Kreide-Formation. *Palaeontographica*, 37: 140–194.
- 1900. Über zwei neue Gattungen aus den ostalpinen Kreideschichten. *Sitzungsberichte der Naturforschenden Gesellschaft zu Leipzig*: 37–40, Leipzig.
- 1903a. Studien über die korallenführenden Schichten der oberen Kreideformation in den Alpen und in den Meditterangebieten. *Palaeontographica*, 49: 163–359.
- 1903b. Korallen aus dem portugisischen Senon. *Zeitschrift der Deutschen Geologischen Gesellschaft*, 55: 45–55.
- 1903c. Verkiesselte Korallen als Geschiebe im Deluvium von Schlesien und Mähren. *Centralblatt für Mineralogie, Geologie und Paläontologie*: 561–577.
- 1906. Über eine Kreidefauna aus der Kreideformation Ost-Galiziens. *Zeitschrift der Deutschen Geologischen Gesellschaft*, 58: 38–52.
- 1914. *Fossilium Catalogus. Animalia, Pars 5–7. Anthozoa palaeocretacea*. 273 pp. Junk, Berlin.
- 1925. *Fossilium Catalogus. Animalia, Pars 28. Anthozoa eoacaenica et oligocaenica*. 296 pp. Junk, Berlin.
- Fossa-Mancini, E.** 1918. Catalogo dei fossili dell'Appennino centrale conservati del Museo di Geologia dell'Università di Pisa. *Palaeontographica Italica*, 24: 129.
- Foster, A. B.** 1986. Neogene paleontology in the northern Dominican Republic. 3. The family Poritidae (Anthozoa: Scleractinia). *Bulletins of American Paleontology*, 90: 43–123.
- Fromentel, E. de** 1857. Description des Polypiers fossiles de l'étage Nèocomien. *Bulletin de la Société des Sciences Historiques et Naturelles de l'Yonne*: 78 pp. Perriquet et Rouillé, Auxerre.
- (1858–1861): Introduction à l'étude des Polypiers fossiles. *Mémoires de la Société d'émulation du Département du Doubs*, 5: 1–357.
- 1862. Zoophytes, terrains crétacés. 2–3). In, d'Orbigny, A. de, *Paléontologie Française*, 8: 49–144. Masson, Paris.
- 1863. Zoophytes, terrains crétacés. 4). In, d'Orbigny, A. de, *Paléontologie Française*, 8: 145–240. Masson, Paris.
- 1867. Zoophytes, terrains crétacés. 6). In, d'Orbigny, A. de, *Paléontologie Française*, 8: 241–288. Masson, Paris.
- 1877. Zoophytes, terrains crétacés. 10). In, d'Orbigny, A. de, *Paléontologie Française*, 8: 433–480. Masson, Paris.
- Goldfuss, A.** 1826–1829. *Petrefacta Germaniae*, 1: 1–114. Arnz, Düsseldorf.
- Gray, J. E.** 1842. In, Agassiz, L. J. R (editor), *Nomenclator zoologicus: continens nomina systematica generum animalium tam viventum quam fossilium*, 5: 130. Sent et Grassmann, Soloduri.
- 1847. An outline of an arrangement of stony corals. *Annals and Magazine of Natural History*, 19: 120–128.
- Gregory, W.** 1900. *Polytrema*s and the ancestry of Helioporidae. *Proceedings of the Royal Society London, (B)* 66: 291–305.
- 1930. The fossil fauna of the Samana-range and some neighbouring areas. Part VII: The Lower Eocene corals. *Memoir of the Geological Survey of India, (NS)* 15 (7): 81–128.
- Guettard, M.** 1770–1777. *Mémoires sur les différentes parties de la physique, de l'histoire naturelle; des sciences et des arts*, 1–3. Costard, Fils et Compagne, Paris.
- Hackemesser, M.** 1936. Eine kretazische Korallenfauna aus Mittel-Griechenland und ihre paläobiologischen Beziehungen. *Palaeontographica, (A)* 84: 1–97.
- Haeckel, E. H. P. A.** 1866. *Genrelle Morphologie der Organismen: allgemeine Grundzüge der organischen Formen-Wissenschaft, mechanisch begründet durch die von C. Darwin reformierte Decendenz-Theorie*, 1, 2. Reimer, Berlin.
- Höfling, R.** 1989. Substrate-induced morphotypes and intraspecific variability in

- Upper Cretaceous scleractinians of the eastern Alps (West Germany, Austria). *Memoir of the Association of Australasian Palaeontologists*, **8**: 51–60.
- Hoppe, W.** 1922. Jura und Kreide der Sinaihalbinsel. *Zeitschrift des Deutschen Palästinaverains*, **14**: 61–219.
- Kennedy, W. J.** 1995. Maastrichtian ammonites from the United Arab Emirates-Oman border region. *Bulletin of The Natural History Museum, Geology*, **51** (2): 241–250.
- Koby, F.** 1889. Monographie des polypiers jurassiques de la Suisse (8). *Mémoires de la Société Paléontologique Suisse*, **15**: 401–456.
- 1905. Description de la faune jurassique du Portugal. Polypiers du Jurassique supérieur. *Commission du Service Géologique du Portugal Lisboa*: 167 pp.
- Kossmat, F.** 1907. Geologie der Insel Sokrota, Semha und Abd el Kuri. *Denkschriften der Akademie der Wissenschaften Wien*, **71**: 1–62.
- Kühn, O.** 1925. Korallen des Miocäns von Eggenburg. *Abhandlungen der geologischen Bundesanstalt Wien*, **22** (3): 1–62, pls 1, 2.
- 1933. Das Becken von Isfahan-Saidabad und seine Altmiocäne Korallenfauna. *Palaeontographica*, **79A**: 143–221.
- 1966. Eozänkorallen aus Österreich. *Sitzungsberichte der Österreichische Akademie der Wissenschaften, Mathematisch-naturwissenschaftliche Klasse*, (1) **179** (9/10): 317–355, pls 1–4.
- Kuzmicheva, E. I.** 1987. Upper Cretaceous and Paleogene corals of the USSR. *Verkhnelye paleogenoye korallij SSSR*: 187 pp. Moscow, Nauka. [in Russian]
- Lamarck, J. B. P. de** 1801. *Système des animaux sans vertèbres*. 432 pp. Deterville, Paris.
- Lambelet, E.** 1968. Die Korallen im Koralln-Oolith mit besonderer Berücksichtigung der Gattungen *Montlivaltia* und *Thecosmilia*. 213 pp. [unpublished PhD thesis, Hamburg]
- Lamouroux, J. U. F.** 1821. *Exposition méthodique des genres de l'ordre des polypiers*. 115 pp. Agasse, Paris.
- Leymerie, A. F. G. A.** 1846. *Statistique géologique et minéralogique du département de l'Aube*. 676 pp. Troyes.
- Linnaeus, C. von** 1758. *Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis*. 10th edition, 823 pp. Holmiae.
- Lioa, Wei-Hua & Xia, Jin-Bao** 1994. Mesozoic and Cenozoic scleractinian corals from Xizang. *Palaeontologica Sinica*, (NS B) **184**: 252 pp. [In Chinese, English summary]
- Löser, H.** 1989. Die Korallen der sächsischen Oberkreide. Hexacorallia des Cenomans. *Abhandlungen des Staatlichen Museums für Mineralogie und Geologie zu Dresden*, **36**: 88–154, 183–186, 209–215.
- 1994. La faune corallienne du mont Kassenberg à Mülheim-sur-la-Ruhr (Bassin crétacé de Westphalie, Nord Ouest de l'Allemagne). *Coral Research Bulletin*, **3**: 1–93.
- 1997. Lower Campanian corals from Amasya (Turkey). *Abhandlungen und Berichte für Naturkunde und Vorgeschichte, Magdeburg*, **20**: 77–87.
- Mallada, L.** 1892. Catalogo general de las especies fosiles encontradas en España. *Boletín de la Comision del Mapa geológico de España*, **18**: 1–253.
- Michelin, H.** 1841–47. *Iconographie zoophytologique. Description par localités et terrains des polypiers fosiles de France*. 348 pp. Bertrand, Paris.
- Milne Edwards, H.** 1857. *Histoire naturelle des Coralliaires ou polypes proprement dits*, (2) **8**: 633 pp. Librairie encyclopédique de Roret, Paris.
- & **Haime, J.** 1848–49. Recherches sur la structure et la classification des polypiers récents et fossiles (4). *Monographie des Astréides*, **XI**: 233–312. Martinet, Paris.
- & — 1851. A monograph of the British fossil corals. Corals from the oolitic formations. *Monographs of the Palaeontographical Society*, **5**: 73–146.
- & — 1857–60. *Histoire naturelle des Coralliaires ou polypes proprement dits*. **I** (1857): 1–326; **II** (1857): 1–633; **III** (1860): 1–560, 31 pls. Paris.
- Morris, N. J.** 1995. Maastrichtian nautiloids from the United Arab Emirates-Oman border region. *Bulletin of The Natural History Museum, Geology*, **51** (2): 251–256.
- & **Skelton, P. W.** 1995. Late Campanian-Maastrichtian rudists from the United Arab Emirates-Oman border region. *Bulletin of The Natural History Museum, Geology*, **51** (2): 277–305.
- Morycowa, E.** 1964. Hexacorallia des couches de Grodzisze (Néocomien, Carpathes). *Acta Palaeontologica Polonica*, **9**: 3–114.
- 1971. Hexacorallia et Octocorallia du Crétacé inférieur de Rarau (Carpathes orientales roumaines). *Acta Palaeontologica Polonica*, **16**: 3–149.
- & **Lefeld, J.** 1966. Karolowce z wapieni urgonskich serii wierchowej Tatr Polskich. *Rocznik Polskiego Towarzystwa Geologicznego*, **36**: 519–542.
- & **Roniewicz, E.** 1990. Revision of the genus *Cladophyllia* and description of *Apocladophyllia* gen. n. (Cladophylliidae fam. n., Scleractinia). *Acta Palaeontologica Polonica*, **35**: 165–190.
- & — 1995a. Scleractinian septal microstructures: taxonomical aspect. In, Lathuilière, B. & Geister, J. (editors), Corals reefs in the past, present and future. *Publications du Service géologique du Luxembourg*, **29**: 269.
- & — 1995b. Microstructural disparity between Recent fungiine and Mesozoic microsolenine scleractinians. *Acta Palaeontologica Polonica*, **40**: 361–385.
- Moseley, H. N.** 1876. On the structure and relations of the Alcyonaria *Heliopora caerulea*, and remarks on the affinities of certain Paleozoic corals. *Philosophical Transactions of the Royal Society of London*, **166**: 91–129, pls 8, 9.
- Oppenheim, P.** 1912. Neue Beiträge zur Eozänfauna Bosniens. *Beiträge zur Paläontologie und Geologie Österreich-Ungarns und des Orients*, **25** (2/3): 87–149.
- 1930. *Die Anthozoen der Gosauschichten in den Ostalpen*. 604 pp. Oppenheim, privately published, Berlin-Lichterfelde.
- Orbigny, A. de** 1849. *Prodrôme de Paléontologie stratigraphique universelle*, **I**: 394 pp. Masson, Paris.
- 1850. *Prodrôme de Paléontologie stratigraphique universelle*. **II**: 428 pp. Masson, Paris.
- Owen, E. F.** 1995. Maastrichtian brachiopods from the United Arab Emirates-Oman border region. *Bulletin of The Natural History Museum, Geology*, **51** (2): 275–276.
- Pöcta, P.** 1887. Die Anthozoen der Böhmisches Kreideformation. *Abhandlungen der Königlichen Böhmisches Gesellschaft der Wissenschaften*, **7**: 1–60.
- Pratz, E.** 1882. Über die verwandtschaftlichen Beziehungen einiger Korallengattungen mit hauptsächlichlicher Berücksichtigung ihrer Septalstruktur. *Palaeontographica*, **29**: 81–124.
- Quenstedt, F. A.** 1881. *Petrefactenkunde Deutschlands* (6); *Röhren- und Sternkorallen*, (3): 913–1094. Fues, Leipzig.
- Reis, O. M.** 1889. Die Korallen der Reiter Schichten. *Geognostische Jahreshefte*, **2**: 91–162.
- Renz, C.** 1930. Neue mittelkretazische Fossilvorkommen in Griechenland. *Abhandlungen der Schweizerischen Palaeontologischen Gesellschaft*, **42**: 1–10.
- 1931. Zur Kenntnis der Gattung *Aspidiscus*. *Abhandlungen der Schweizerischen Palaeontologischen Gesellschaft*, **51**: 3.
- Reuss, A. E.** 1854. Beiträge zur Charakteristik der Kreideschichten in den Ostalpen, besonders im Gosauthale und am Wolfgangsee. *Denkschriften der kaiserlichen Akademie der Wissenschaften, Mathematisch-Naturwissenschaftliche Classe*, **7**: 73–133.
- 1864. Die fossilen Foraminiferen, Anthozoen und Bryozoen von Oberburg in Steiermark. *Denkschriften der kaiserlichen Akademie der Wissenschaften, Mathematisch-Naturwissenschaftliche Classe*, **23** (1): 1–38.
- 1868. Paläontologische Studien über die älteren Tertiärschichten der Alpen. 1. Abteilung. Die fossilen Anthozoen der Schichten von Castelgomberto. *Denkschriften der kaiserlichen Akademie der Wissenschaften, Mathematisch-Naturwissenschaftliche Classe*, **28** (1): 129–184.
- Reyer Navarro, M. M.** 1963. Corales del Cretacico inferior de San Juan Raya, Estado de Puebla. *Paleontologia Mexicana*, **17**: 1–21.
- Roniewicz, E.** 1976. Les scléactiniaires du Jurassique supérieur de la Dobrogea centrale Roumanie. *Palaeontologica Polonica*, **34**: 17–121.
- 1996. The key role of skeletal microstructure in recognizing high-rank scleractinian taxa in the stratigraphical record. In, Stanley, G.D. Jr. (editor), Paleobiology and Biology of Corals. *The Paleontological Society Papers*, **1**: 187–206.
- Sanders, D. & Baron-Szabo, R. C.** 1997. Coral-rudist bioconstructions in the Upper Cretaceous Haidach section (Gosau Group; Northern Calcareous Alps, Austria). *Facies*, **36**: 69–90.
- Schuster, F.** 1996. Paleocology of Paleocene and Eocene corals from the Kharga and Farafa Oases (Western Desert, Egypt) and the depositional history of the Paleocene Abu Tartur carbonate platform, Kharga Oasis. *Tübinger geowissenschaftliche Arbeiten; A: Geologie, Paläontologie, Stratigraphie*, **31**: 96 pp.
- Schweigger, A. F.** 1819. *Beobachtungen auf naturhistorischen Reisen. Anatomisch-physiologische Untersuchungen über Corallen: nebst einem Anhang, Bemerkungen über den Bernstein enthaltend*. 127 pp. Berlin.
- Scott, W. R.** 1981. Biotic relationships an Early Cretaceous coral-algal-rudist reefs, Arizona. *Journal of Paleontology*, **55** (2): 463–478.
- Sedgwick, A. & Murchison, R. J.** 1832. A sketch of the structure of the Eastern Alps, with sections through the newer formations on the northern flanks of the chain etc. *Transactions of the Geological Society*, (2) **3**: 1–301.
- Skelton, P. W., Nolan, S. C., & Scott, R. W.** 1990. The Maastrichtian transgression onto the northwestern flank of the Proto-Oman Mountains: sequences of rudist-bearing beach to open shelf facies. In, Searle, M. P., Robertson, A. H. F. & Reis, A. C. (editors), The Geology and Tectonics of the Oman Region. *Geological Society Special Publications*, **49**: 521–547.
- Smith, A. B.** 1995. Late Campanian-Maastrichtian echinoids from the United Arab Emirates-Oman border region. *Bulletin of The Natural History Museum, Geology*, **51** (2): 121–240.
- , **Morris N. J., Kennedy, W. J. & Gale, A. S.** 1995a. Late Cretaceous carbonate platform faunas of the United Arab Emirates-Oman border region. *Bulletin of The Natural History Museum, Geology*, **51** (2): 91–119.
- , —, **Gale, A. S. & Rosen, B. R.** 1995b. Late Cretaceous (Maastrichtian) echinoid-mollusc-coral assemblages and palaeoenvironments from the Tethyan carbonate platform succession, northern Oman Mountains. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **119**: 155–168.
- Söhle, U.** 1899. Das Ammergebirge. *Geognostische Jahreshefte*, **2**: 1–90.
- Solé Sabaris, D. L.** 1942. Fauna coralina del Eoceno catalán. *Memorias de la Real Academia de Ciencias y Artes de Barcelona*, **26** (9): 259–440.
- Stoliczka, F.** 1873. Cretaceous fauna of southern India. *Memoir of the Geological Survey of India, Palaeontologia Indica*, **IV** (4): 131–202.
- Taylor, P. D.** 1995. Late Campanian-Maastrichtian Bryozoa from the United Arab

- Emirates-Oman border region. *Bulletin of The Natural History Museum, Geology*, **51** (2): 267-274.
- Trauth, F.** 1911. Die oberkretazische Korallenfauna von Klogsdorf in Mähren. *Zeitschrift des Mährischen Landesmuseums*, **11**: 85-184.
- Turnšek, D.** 1972. Upper Jurassic corals of southern Slovenia. *Razprave Slovenska Akademija Znanosti in Umetnosti* (4), **15** (6): 147-265.
- 1978. Solitary Senonian corals from Stranice and Mt Medvednica (NW Yugoslavia). *Razprave Slovenska Akademija Znanosti in Umetnosti*, (4) **21** (3): 66-125.
- 1994. Upper Cretaceous reef building colonial corals of Gosau facies from Stranice near Slovenske Konjice (Slovenia). *Razprave Slovenska Akademija Znanosti in Umetnosti*, (4) **35** (1): 3-41.
- 1997. *Mesozoic corals of Slovenia*. 512 pp. Znanstvenoraziskovalni Center SAZU, Ljubljana.
- & **Buser, S.** 1974. The Lower Cretaceous corals, hydrozoans and chaetetids of Banjska Planota and Trnovski Gozd. *Razprave Slovenska Akademija Znanosti in Umetnosti* (4), **17**: 85-124.
- & ——— 1976. Cnidarian fauna from the Senonian breccia of Banjska Planota (NW-Yugoslavia). *Razprave Slovenska Akademija Znanosti in Umetnosti*, (4) **19**: 39-88.
- & **Polšak, A.** 1978. Senonian colonial corals from the biolithite complex of Orešje on Mt. Medvednica (NW Yugoslavia). *Razprave Slovenska Akademija Znanosti in Umetnosti*, (4) **21** (4): 129-180.
- Vaughan, T. W.** 1919. Fossil corals from central America, Cuba, and Porto Rico, with an account of the American Tertiary, Pleistocene, and Recent coral reefs. *Smithsonian Institution Bulletin*, **103**: 189-524.
- & **Wells, J. W.** 1943. Revision of the suborders, families and genera of the Scleractinia. *Geological Society of America, Special Paper*, **44**: 363 pp.
- Verrill, A. E.** 1865. List of polyps and corals sent by the Museum of Comparative Zoology to other institutions in exchange, with annotations. *Bulletin of the Museum of Comparative Zoology*, **1** (3): 29-60.
- Vetters, H.** 1925. Über kretazische Korallen und andere Fossilreste in nordalpinen Flysch. *Jahrbuch der Geologische Bundesanstalt Wien*, **75**: 1-18.
- Wells, J. W.** 1932. Corals of the Trinity Group of the Comanchean of Central Texas. *Journal of Paleontology*, **6** (3): 225-256.
- 1933. Corals of the Cretaceous of the Atlantic and Gulf Coastal Plains and Western Interior of the United States. *Bulletins of the American Paleontology*, **18** (67): 1-207.
- 1934. Some fossil corals from the West Indies. *Proceedings of the U.S. Natural Museum, Washington*, **83** (2975): 71-110.
- 1944. Cretaceous, Tertiary and Recent corals, a sponge, and an alga from Venezuela. *Journal of Paleontology*, **18**: 429-447.
- 1956. Scleractinia. In, Moore, R. C. (editor), *Treatise on Invertebrate Paleontology*, Part F: 328-444.